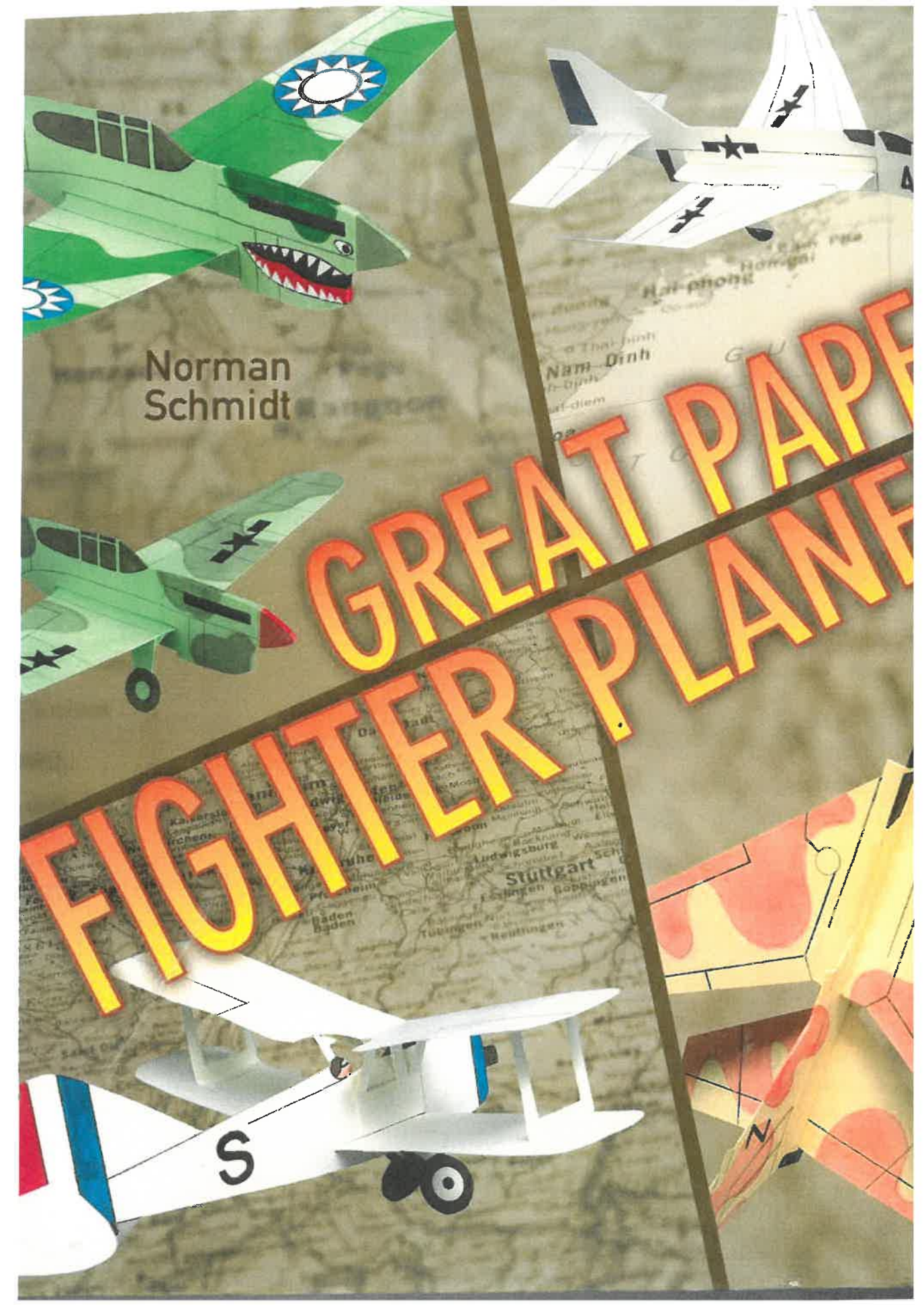
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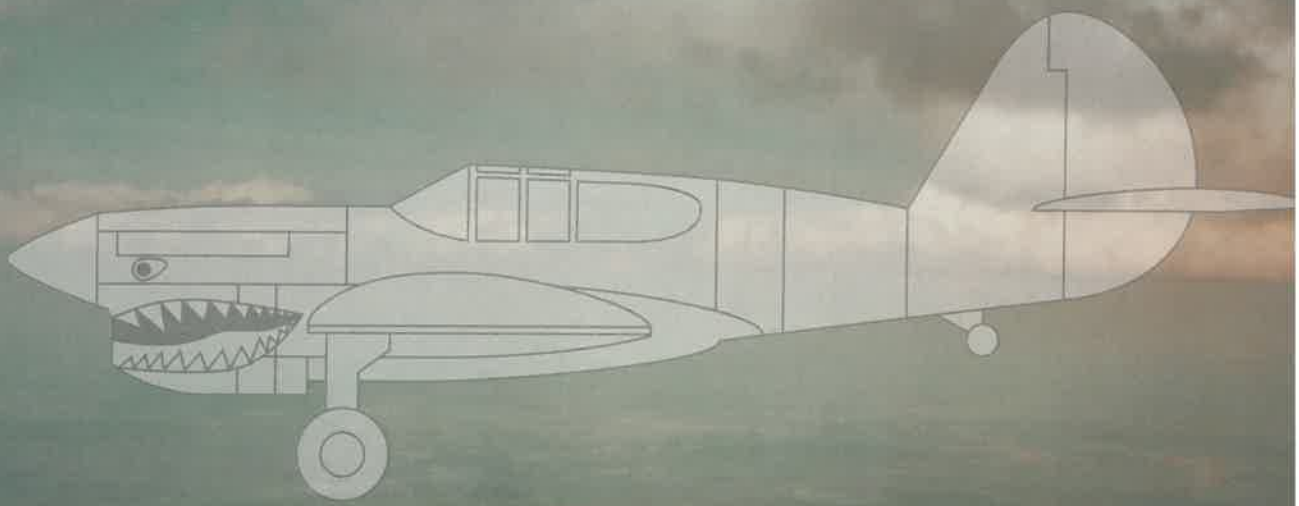
FIGHTER PLANE

Norman Schmidt



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Sterling Publishing Co., Inc. New York
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'ark Avenue South, New York, NY 10016-8810

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Vales Avenue, Winnipeg, MB, Canada R2M 2S9

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buted in Canada by Sterling Publishing Co., Inc.
Canadian Manda Group, 1 Atlantic Avenue, Suite 105
ıto, Ontario, Canada M6K 3E7
buted in Great Britain and Europe by Chris Lloyd at Orca
Services, Stanley House, Fleets Lane, Poole BH15 3AJ,
nd
buted in Australia by Capricorn Link (Australia) Pty Ltd.
Box 704, Windsor, NSW 2756, Australia

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IONAL LIBRARY OF CANADA
ALOGUING IN PUBLICATION

ıidt, Norman, 1947-
eat paper fighter planes / Norman Schmidt.

[1-895569-84-2

Paper airplanes. 2. Airplanes--Models. 3. Fighter
s--History. I. Title.

'8.S354 2004 745.592 C2003-906418-2

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ıidt, Norman.
'eat paper fighter planes / Norman Schmidt.
p. cm.
cludes index.
BN 1-895569-84-2
Paper airplanes. 2. Fighter planes--Models. I. Title.

78.S3623 2004
592--dc22 2044049144

Books Inc. acknowledges the financial support of the Government of Canada through the
ublishing Industry Development Program (BPIDP) for our publishing activities.

J 1-895569-84-2

During the Second World War toys made from paper became popular because other materials strategic to the war effort were not available. Paper airplanes were of particular interest because aircraft played such an important role in the war. They were available for purchase individually or in books containing several models. Breakfast cereal companies also included paper models of famous warplanes as part of their promotions and printed patterns sometimes appeared on the boxes. All of these were cut out and fitted together by enthusiastic would-be aviators.

Such models inspired me to use cereal boxes to make my own toy creations when I was young in the early 1950s. Growing up in a large family meant there were plenty of boxes available. The boxes were turned into paper houses, fences, trees, even people and barnyard animals, but especially airplanes. As a youngster I thought my cereal box airplanes were the greatest. I was influenced by the pictures and stories about aircraft, including those of World War II that still appeared in popular magazines, and by actual surplus warplanes that had found their way into neighboring farmyards where their parts were used to fix farm machinery.

I made profile fuselages by laminating several layers of cereal box paper together to give them strength. The bent tab method was used for attaching the wings and tailplanes. The cereal boxes even provided ready-made random color! For determining balance I attached nails of various sizes to the nose for weight until I found the right ones for successful flight. In this manner I made an assortment of paper aircraft that looked realistic enough and flew sufficiently well to satisfy me as an eight-year-old aviator. At the time I didn't think to balance the planes using additional layers of paper in the nose, but as I experimented with lighter-weight materials and various construction techniques, and as I learned more about aerodynamics, my planes in time became more elegant with balance designed into the structure, as in the models in this book.

Fighter airplanes are of ongoing interest because they make up such an important part of aviation history. There is an irony in this. Although fighters are products of the unusual circumstances of war and are deadly and destructive in use, their design has influenced how all kinds of civilian airplanes in everyday use look and perform. Some fighters are also considered to be among the most beautiful machines ever made. Using representative examples, the development of these airplanes over the last one hundred years make up the content of this book.

The advice and directions given in this book have been carefully checked, prior to printing, by the Author as well as the Publisher. Nevertheless, no guarantee can be given as to project outcome due to possible differences in materials and construction and the Author and Publisher will not be responsible for the results. The paper planes are modeled after historic or existing aircraft and their resemblance to any other models is purely coincidental.

wood-type model airplane glue can be used. However, it is easier to manage the drying time and reduce warpage with stick glue.

When building up the main parts in layers, apply glue to the entire smaller piece to be fastened to a larger one. Press parts firmly together. Continue until the entire main part is completed.

Lay the assembled fuselage flat between clean sheets of paper underneath a weight (some heavy books) until the glue is sufficiently set. This will take between 30 and 45 minutes for stick glue, and longer for white glue. When dry, the glue acts as a stiffener for the model.

STEP 6
Build the wings

Symmetry is essential for wings. Special care must be taken in the wings of biplanes. Make sure that the struts are carefully positioned at the points indicated so that upper and lower wings align at the leading (front) edges.

The dihedral angle (upward slanting of wings from center to tips) must be adjusted while the parts are being assembled, before the glue is set. (Consult the angle guide given with each model.) If stick glue is used, simply prop up the wings at the tips until the glue has set. If white glue (or model glue) is used, drying the wings is more complicated. Some means must be devised to keep each wing from warping while maintaining the dihedral angle.

STEP 7
Adding details

When the glue is dry, but before the model is assembled, is the time to add decoration and color such as numbers, insignia, and camouflage. For this use colored pencils and/or non-toxic felt-tipped markers. As much or as little detail as you wish may be added.

STEP 8
Put it all together

To assemble the model, apply white glue to the bent-over tabs that join the wings and horizontal stabilizer to the fuselage. Align the wings and stabilizers carefully. Press glued parts together. For those models with fixed undercarriage, use white glue to fasten wheels where indicated. Adjust placement of parts carefully, viewing the plane from the top, the front, and the back. Symmetry and straightness in the completed plane are essential. Allow plenty of time for glue to dry.

STEP 9
Wing camber and washout

This is a critical step. Cambering the wings gives them their ability to generate aerodynamic lift. Washout aids in flight stability. For washout gently twist each wing until the trailing edge at the wingtip is higher than at t
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TO BUILD A MODEL

STEP 1
Make photocopies

Nothing is cut out of the book. Instead, make same-sized photocopies (100%) of the pages containing the parts for building the paper models. **Parts pages are found at the back of the book, beginning with page 66.**

STEP 2
Prepare parts for cutting

Each photocopied page contains 2 sections. Cut them apart. Each section fits a standard 5 x 8 inch index card. The parts for each model occupy either 3 or 4 sections. Tack-glue each photcopied section to an index card by applying glue to the backside aligning with the edges of the card. For this use low-tack glue (e.g. Elmer's Office Self Stick Notes glue. Alternatively, regular glue can be used, gluing between the parts only.) The parts are now ready to cut out.

STEP 3
Advanced planning

Before beginning to cut out the parts, score those parts that will need to be bent later (lines are shown in red on each parts page). Then cut opening slits in fuselage parts (lines shown in green). Score and cut precisely on the lines.

STEP 4
Cut out the parts

Cut out each part shown. This must be done carefully, since the success or failure of every other step depends on accurately made parts.

Cut through both the tacked on photocopied layout paper and the card stock underneath. Remove the part and discard the photocopied paper. This leaves a clean unmarked airplane part, ready for assembly. Keep track of the parts by lightly writing the part number in pencil on the backside of each part.

For all the cut-out pieces, the side that faces up for cutting will be outward or upward facing on the finished plane. This is important for aerodynamic and aesthetic reasons.

STEP 5
Build the fuselage

Follow the sequence shown in the assembly diagrams (an exploded view) given for each model. Begin with the number 1 fuselage part, adding the other smaller parts on each side to complete the fuselage. Note which is the front of each part (marked with a small arrow). Align parts carefully. Take care to position the bent over parts accurately because they are the fastening tabs for wings and horizontal stabilizer.

Stick glue (e.g. Uhu Color Stic), white craft glue, or

1903

Aviation Begins

Two enterprising brothers, Orville and Wilbur Wright, were the first to achieve controlled flight of a powered heavier-than-air winged aircraft. The year was 1903. Soon there were aerial displays everywhere as other inventors showed off their own powered airplanes to an amazed public. Amidst the friendly competition of these events a climate of international camaraderie grew among aviators. Newspaper stories glamorized these events by portraying dashing heroes on gleaming aerial mounts. In reality many of the primitive airplanes were fragile, barely holding together; some were difficult to handle, others lacked enough power for sustained flight. Mishaps were not uncommon. Between events various improvements were made and pilots honed their skills in controlling the machines.

At first, flight remained a novelty. But as improvements continued, aircraft were put through various tests in carrying useful things, such as mail. Some of the more ambitious aviators, the Wright brothers among them, also conducted experiments in the military application of their machines. At first these demonstrations were met with skepticism; military officials were not easily convinced that this novel invention might actually be useful to them. Furthermore, before that time it had generally been understood that to shoot or drop things from above was to treat an enemy unfairly. At one time it was even considered to be a crime of war. But there were small skirmishes in various places around the world where airplanes were actually engaged in combat, which confirmed their military usefulness. For example, in the Italian-Turkish conflict of 1911 the first bombs were dropped, and in 1913 during the Mexican Revolution the first recorded incident of pilots firing weapons at each other in the sky took place. Gradually, as the idea of using airplanes in combat became more acceptable, several countries established small air forces.

World War I

As nationalism grew in Europe at the turn of the 20th century, various peoples and language groups came together under central governments. To further their own interests, many of these nations also formed military alliances, creating tensions between governments. Historically, there are four causes of war: the need for land to live on, a desire to possess the wealth of a neighbor, a wish to exercise power in the world, and the necessity to establish security against a perceived threat. In the summer of 1914 war erupted when Austria-Hungary and Serbia were unable to come to terms on one or more of these points. Immediately oth-

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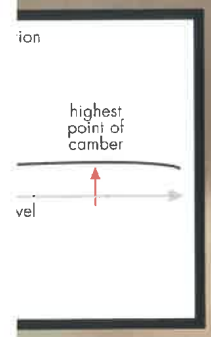

point of camber
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of the wing.

The author with the Spitfire model. Avoid flying where the planes run into things, as this destroys them prematurely. Test flights and some competition flights can be done satisfactorily indoors, if a large enough space is available. The best place is a grassy out-of-doors area away from obstacles and traffic, where the paper planes can catch the breeze or even updrafts to fly a good long way, as well as have a soft landing.

To avoid injury, never fly a paper airplane toward another person.

more than glorified scouts in an aerial cavalry; flying horsemen wielding pistols and carbines. Yet by making warriors of aviators they became even greater heroes, virtually knights in shining armor, which was reinforced by the chivalry that continued. Opposing pilots had so much respect for one another at this time they would throw a wreath when an enemy plane was shot down. Skill was recognized universally and any pilot with five or more victories was declared an ace, a tradition remaining to this day.

Aerial combat put temperamental airplanes to the ultimate test as one pilot tried to out-turn, out-dive, and out-climb his opponent in the attempt to shoot him out of the sky. In this deadly competition pilots invented many evasive and attack maneuvers that have ever since been standard for all fighter pilots. In these maneuvers airframes and powerplants were pushed to the limit of their durability. Many planes could not withstand such harsh treatment and broke up in flight. Others, those hard to maneuver or the woefully underpowered, became sitting ducks, and were readily shot down. Because of the extreme rigors of warfare, deficencies in airplanes were always immediately apparent. A tradition began of continually improving airframes, engines, and armament as soon as a particular type of airplane entered service. For this reason all the combatants tried to capture airplanes from their opponents so they could do them one better with their next model.

To facilitate airplane development, experimentation centers with government sponsorship were established, and a new industry sprang up. The making of airplanes became a growing enterprise as many existing manufacturers, especially those with experience in woodworking and furniture making, turned their attention to building airplanes. It was the same in all combatant countries. The war became a manufacturing race to see who could build the best airplanes in sufficient numbers. While at the war's outset this fledgeling industry could produce only a few airplanes with the combined totals of all the countries involved numbering only in the hundreds, by the end of the war each country had built many thousands of airplanes (Germany with 48,000; Britain had a similar production with 47,000; France contributed approximately 25,000, with smaller numbers by others). Even with these seemingly large numbers, airplanes accounted for only a small portion of the total machinery of war, and the air battles were small in the scheme of the entire war. Yet the military role of airplanes became firmly established in World War I and in future wars they became even more important.

The innovative Fokker company supplied many types

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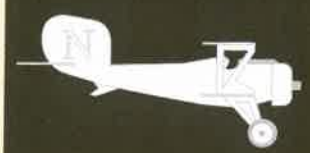
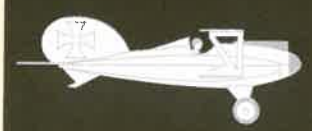
ers took sides. Austria-Hungary, Germany, Bulgaria, and the entire Ottoman Empire formed one group, called the Central Powers. Serbia, France, Belgium, the British Commonwealth, and Russia formed another group, called the Allied Powers. Within months they were all at war. Other countries joined later. The Great War, the war to end all wars – World War I – began.

Nationalism fostered industrial growth and manufacturers daily invented new mechanical devices of all kinds, including machines to make armies stronger. Whereas traditionally European wars had been fought and won by professional soldiers not directly involving civilian populations, now manufacturing nations became "nations-in-arms" because manufacturers employed large segments of the population and everyone's day-to-day business contributed to the nation's military might. Combatant countries, with their growing industries, immediately used a variety of mass-produced machines to wage war – machine guns, iron-clad tanks, heavy field artillery, armor-plated battleships, submarines, and now, flying machines.

Despite many advances airplanes were still little more than powered kites – a mass of canvas, sheet metal, wooden struts, and wire braces – frail indeed amidst the other war-making machinery. At first these fragile machines were considered suitable mainly for reconnaissance, the same role balloons had filled in the armed forces alongside cavalry scouts on horseback. However, airplanes proved to be so much more mobile than either balloons or horses as they sped back and forth high above enemy encampments, observing activities in greater detail than had ever been possible before. In the early days of the conflict no armament was carried during these flights and the friendly camaraderie established among fliers before the war persisted. Occasionally opposing pilots on mission actually waved and saluted from their open cockpits. But because of the damaging reports these pilots were able to give to the commanders on the ground, before long more was demanded of them. Leaders realized that control of the skies might influence the war's outcome and reconnaissance pilots were obliged to take small arms with them into the sky to fire at the enemy planes if they gave chase. Fliers became warriors. What had been friendly competition in an international fraternity before the war, was now a deadly game as opposing pilots turned to the serious business of eliminating one another from the air.

In reality the random firing of hand-held weapons while airborne was quite ineffective. Firing in one direction while flying in another made it next to impossible to hit a moving target. Pilots remained little





weapon all at the same time. This prompted others to fix the gun on the airplane's cowl directly in the pilot's line of sight, firing through the spinning propeller. To keep the propeller from being damaged, metal protective deflector wedges were attached to its edges. This was better but still not satisfactory since too many rounds striking the wedges went astray. This eventually led to the invention of a machine gun that was synchronized with the speed of the engine, firing only between the blades of the spinning propeller. This solution, perfected first by Anthony Fokker, is what made the E.Is and E.IIIs such deadly fighters.

Yet armament alone was not enough. Maneuverability and engine power were just as necessary for effective fighter planes in order to out-fly and out-turn the opponent and get into an advantageous position to fire. It was not until the summer of 1916 that the French introduced fighters that matched or exceeded Fokker performance, such as the Nieuport 17 biplane. [MODEL #2 p 18] With its synchronized gun and good maneuverability, this plane was much loved by French and British pilots, allowing many to become aces. The British, too, introduced fighters with improved combat performance that year, such as the Airco D.H. 2. Once the firepower of the Fokkers was matched their total domination of the air ended. However, German aircraft manufacturers continued to build excellent fighter models and remained formidable foes, frequently holding the upper hand for periods of time.

The airplane manufacturer, Albatros, had a reputation for building wooden biplanes of exceptional quality and became another major supplier to the German military. With their lightweight, graceful lines, and powerful engines, Albatros machines had excellent maneuverability and tremendous speed and rates of climb. Weight was kept down by their semi-monocoque construction in which plywood skins provided structural strength. These planes also performed successfully at high altitude, giving them a distinct advantage in combat. Albatros introduced for the first time twin guns, a practice to become standard on all fighters during the latter years of the war. This gave the fighter added punch, increasing the rate of victories. One Albatros weakness was that in certain maneuvers their wing struts could fail. Despite this the Albatros D.III model [MODEL #3 p 20] had such good combat performance that it became the standard front line machine and helped the Central Powers to regain, briefly, air superiority in 1917. Most of the Red Baron's victories were made flying an Albatros. During the air battles of "Bloody April" more French and British planes were

HANDLING PA MODELS

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PREFLIGHT IN

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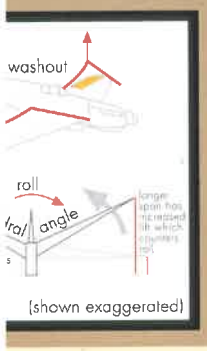
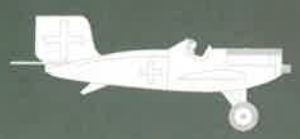


of airplanes for the German military during the course of the war, experimenting with monoplanes, biplanes, and triplanes. The monoplane with its single pair of wings had certain aerodynamic advantages, yet it remained fragile and the drag of the many wire braces strung from posts above and below to support the wings canceled the aerodynamic advantages. For this reason, until strong lightweight materials were available, together with improved construction techniques, most World War I fighters were biplanes (airplanes with two sets of wings one above the other like a box kite). Joined with wooden struts and pairs of crossed wire braces, this arrangement of wings provided adequate strength. It also made for shorter wings, which improved maneuverability. In an attempt to further improve maneuverability Fokker, as well as some other manufacturers, also built triplanes – three sets of very short wings. The most famous was the bright red Fokker Dr.I flown by Manfred von Richthoffen, the Red Baron, the German pilot who became the all-time ace by single handedly downing 80 planes.

The first purpose-built fighter, designed to pursue other aircraft, came from Fokker in 1915 – the **Fokker E.I Eindecker** (monoplane). [MODEL #1 p 16] While not especially fast or maneuverable, its success lay in the fact that for the first time an effective gun was fitted to an airplane. The war took a turn. The introduction of this model gave the Central Powers, under Germany's lead, an immediate advantage in the air. With the introduction of the improved E.III model they maintained the upper hand throughout the year and into the next in what was called the "Fokker Scourge." Because French and British planes remained poorly armed and could not defend themselves, they were routinely shot down. The year 1916 was a time of crisis in the war.

Armament posed a special problem. The task was to make a rapid firing gun that was a permanent fixture of the airframe, firing forward in the direction of flight so that the whole airplane could be maneuvered to aim the gun. Most airplanes had the engine and propeller at the front. This meant that the pilot could fire the gun only in a direction away from the spinning propeller so as not to damage it. At first the machine gun was mounted to swing freely to the side. But this arrangement was little better than a hand held weapon. Although the gun was bigger, it was still just as much an impossibility to hit a moving target by firing in one direction while flying in another. In an attempt to make the gun fire in the direction of flight some manufacturers fixed the gun high up outside the propeller arc. This mounting made it difficult for the pilot, sitting low down, to fly the plane, aim, and fire the



Mechanized warfare gave birth to strategic bombing. Large machines, some with four or even six engines, carried heavy bomb loads deep into enemy territory, to drop them on factories and other civil installations necessary for the enemy to wage war. With the thought that unsuspecting civilians – men, women, and children, were subject to the possibility of instant death from the skies – the glamor and romance of flight turned into fear and dread. With strategic bombing the terms air power and total war came into being; with airplanes the total domination of one nation by another became possible. Fighter planes took on two additional roles: they escorted the less maneuverable bombers, providing protection against attack by enemy fighters. They also intercepted incoming enemy bombers. Airplanes had become agents of terror, yet pilots continued to hold one another in high regard. When the Red Baron was shot down in 1918, a memorial service was given out of respect by those responsible for his demise.

Increasingly airplanes of high quality were built by both sides. Fighters attained speeds of 130 mph (200 km/h) or more and operated at 20,000 ft (6000 m). Bomb loads of about 2 tons became possible. By 1917 large-scale air battles were fought between squadrons of up to 50 airplanes. Slowly the Allied Powers were gaining the upper hand.

In a last effort at air supremacy the Germans introduced two fighters early in 1918, the Fokker D.VII and the **Junkers D.I.** [MODEL #6 p 26] While the Fokker D.VII was a superb fighter, possibly the best of all the German machines, the Junkers factory demonstrated remarkable ingenuity with its machine. The D.I monoplane revolutionized airplane design. Made entirely of metal and affectionately called the Tin Donkey, this was a radical departure from conventional airplane design making it slow in being accepted. Only forty-one airplanes reached the front lines before the Armistice in November of 1918. This airplane was many years ahead of its time. Among its unique features were fully cantilevered wings that had all support contained internally, eliminating the need for any external struts or wires. This streamlining improved flight performance. Its metal construction also offered greater protection from ground fire, making it especially suited to low level ground attack. This airplane also came radio equipped.

The many features found in the Junkers D.I would eventually become standard in fighters, as well as in other airplanes. Wartime methods of construction and manufacture established patterns upon which every modern streamlined airplane would be built in the future. World War I greatly speeded up the process of

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shot down than at any time in the war.

The losses of 1917 were due in no small part to new German tactics of deploying fighters in large formations called circuses, of which the Red Baron was a skilled proponent. Prior to that time most air encounters were between individual pilots. For the Allied Powers the new tactics meant concentrating their airplanes by pulling them from various regions, leaving those areas undefended until more machines were available. Total air defeat was avoided only because French and British manufacturers worked feverishly and were able to provide the needed planes.

Two airplanes in particular helped turn the tide in favor of the Allied Powers in 1917. One was the **Sopwith Camel.** [MODEL #4 p 22] This airplane was the first British airplane to have twin guns, and got its curious name because the faring covering the guns gave it a distinctive hump on the cowl. With its great agility, it was an excellent combat performer, ultimately responsible for downing more enemy planes than any other – 1294 in all. However, its performance came at a price. Like real camels, which sometimes bit their owners, the Sopwith could also bite its pilots, especially novice pilots. It required deft handling. Its maneuverability also gave it the tendency to spin, which claimed the lives of almost half as many pilots as those who lost their lives on this model in combat. Nonetheless, the spritely Sopwith Camel was considered by many to be the best all-around fighter of the war. It was built in large numbers, nearly 6000 planes.

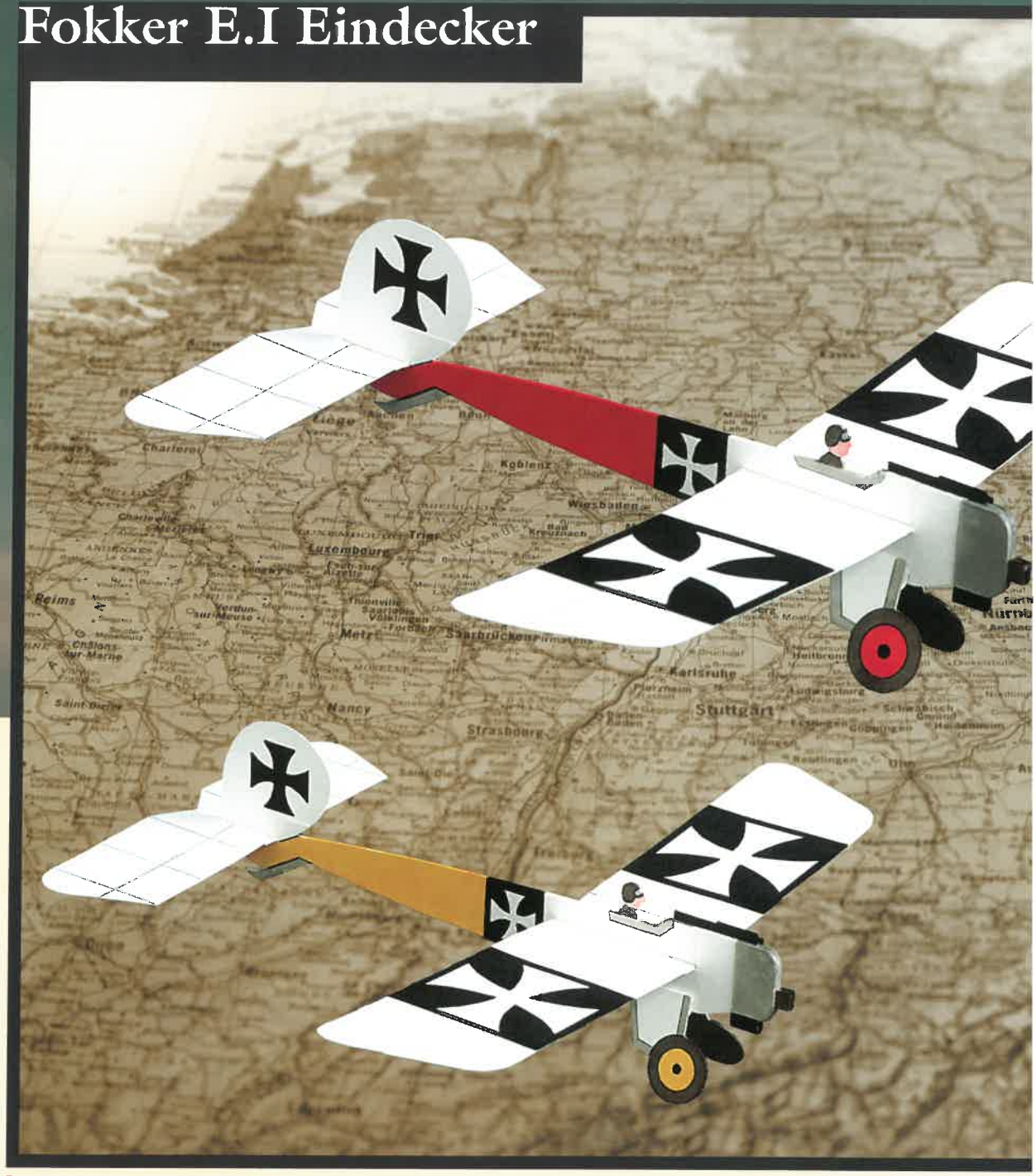
The other fighter to help tip the balance was the French **Spad XIII,** [MODEL #5 p 24] introduced at about the same time. It was a first-class fighter featuring twin guns and was fast and maneuverable. After the United States entered the war that same year, many of its pilots were assigned Spads. Many also became aces. This airplane continued in production with 8000 machines in service by the time hostilities ceased.

Besides fighters, there were various airplanes for ground attack. Some were used to bomb enemy installations, others to provide firepower support for troops on the ground. In addition to this, airplanes were used as spotters directing shellfire. Airplanes also harassed enemy camps making life difficult for soldiers. Others were dedicated to reconnaissance to gather information and then get out of enemy airspace unharmed to deliver their findings. The introduction of cameras and radios on board, both relatively new inventions at the time, improved their work.

The use of heavy bombers introduced something more sinister. For the first time in history they took the war away from the battlefronts.

#1

Fokker E.I Eindecker



[SEE TEXT p 11]

Year: 1915
Country of origin: German
Manufacturer: Fokker Flug
Type: Single-seat fighter
Engine: 100 hp Oberursel
air cooled rotary
Wingspan: approx 31 ft (9
Length: approx 24 ft (7 m)
Height: approx 9 ft in (3 m
Weight: 1342 lb (610kg)
Maximum speed: 88 mph
Ceiling: 11,500 ft (3500m)
Range: 113 miles (182 km)
Armament: One machine g

Note: Given the fact that fighter design evolved rapidly in the 20th century, specifications for each fighter type varied considerably depending on exactly when and where it was produced. What is given in this book are generalizations.

converting the novelty of flight into something practical after the war.

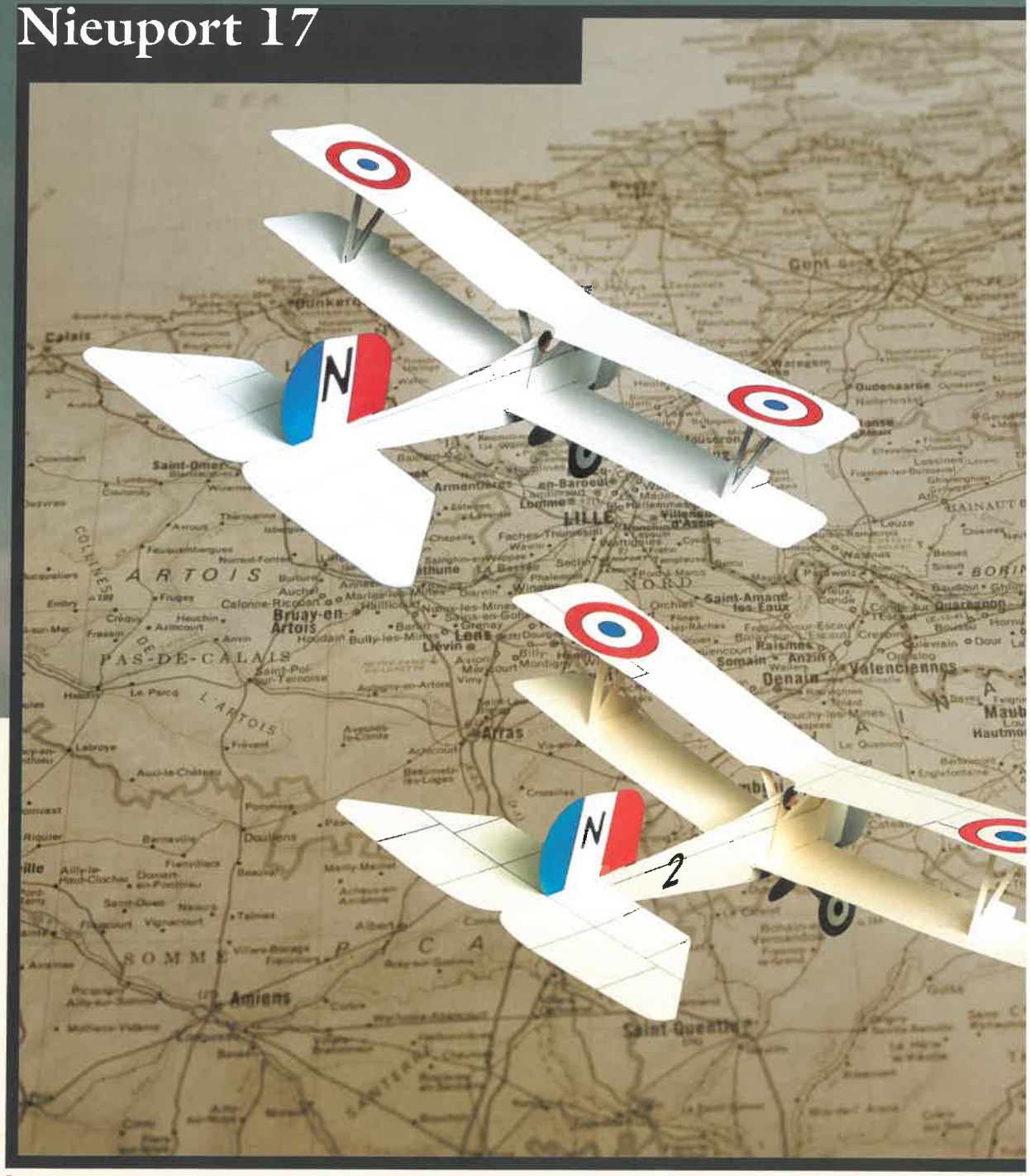
Progress after World War I

After the Armistice, however, the aviation industry went into a slump since few uses other than military had been established for the airplane and only small air forces were retained for peacetime defense. Despite the innovative features found on the Junkers D.I, airplane construction remained more or less the same everywhere until the 1930s. Although fighter airplanes had increasingly more powerful engines and added streamlining features such as wheel farings to give overall increases in speed and performance, most remained as wood and metal framed fabric-covered biplanes with open cockpits. Standard armament remained the twin synchronized machine guns mounted on the cowl in the pilot's line of sight. Various enterprising individuals applied the lessons learned in combat and pushed airplane design ahead by building racers, and just as they had done before the war, airplanes once again engaged in friendly competition. Racing meets, stunt flying events (called barnstorming), and aerobatic displays (basically combat maneuvers done to please onlookers), gave the aviation industry the ongoing experience it needed, and helped generally in the development of new airplane designs. Charles Lindbergh's daring solo flight across the Atlantic ocean in 1927 put aviation on everyone's mind, reaffirming the pilot-as-hero sentiment. With the horrors of war a dim memory, glamor returned to aviation. Many individuals took up flight as a pastime.

Attention now focused on aerodynamic efficiency and speed. For this the monoplane was especially well suited, and in the course of time its performance far surpassed anything Junkers had achieved with the D.I. This was due to several factors. First, aerodynamic research showed how important airframe shape and streamlining were to performance. Strong and lightweight aluminum, already used during the war, was now in abundant supply. This material was suited to making both structural parts and, in sheet form, the covering of the airframe. It could be formed into just the right shape for good high-speed airframes, and could be polished to a drag-reducing mirror-like finish. Next, improved methods of refining gasoline yielded much more potent high octane fuel, increasing engine power. Along with this, other ways were discovered to profoundly increase power output without making engines much bigger or heavier. Their development progressed along two lines. Air cooled radial engines had been traditional for lightweight airplanes and had certain advantages. Without the added

text continues on p 28

Nieuport 17



[SEE TEXT p 12]

Year: 1916
Country of origin: France
Type: Single-seat fighter
Engine: Le Rhône 9J, 9 cylinder,
Wing Span: 26 ft 11 in (8.22 m)
Length: 18 ft 10 in (5.74 m)
Height: 7 ft 10 in
Weight: 1246 lb (565 kg)
Max Speed: 110 mph (177 kmh)
Ceiling: 17,388 ft (5,300 m)
Endurance: 2 hours
Armament: 1 Lewis machine gun

MBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.

STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

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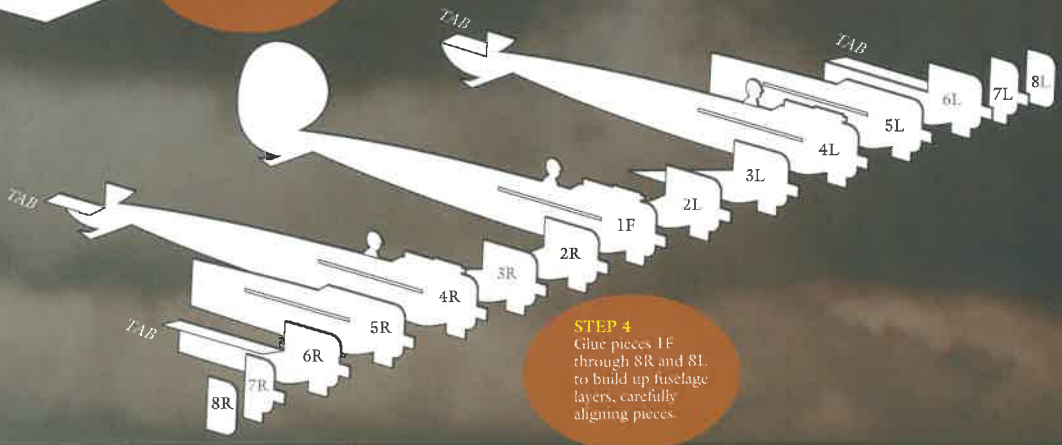
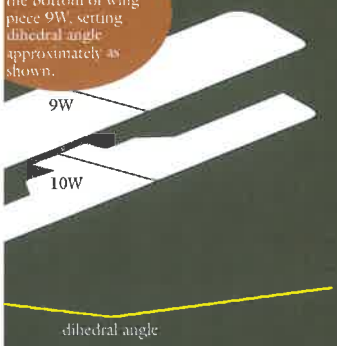


STEP 4
Glue pieces 1F through 8R and 8L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.



STEP 6
Applying glue, insert wheel piece 11R into folded wheel piece 12R. Fold over the attachment tab and apply glue.

STEP 7
Applying glue, insert wheel piece 11L into folded wheel piece 12L. Fold over the attachment tab and apply glue.

STEP 8
Applying glue to the tail tabs, fasten horizontal stabilizer 13S to the fuselage.

STEP 9
Insert wings into fuselage and apply glue to the wing tabs to fasten.

STEP 10
Apply glue to the wheel attachment tab of left and right wheel parts, fastening each fuselage at position lines.

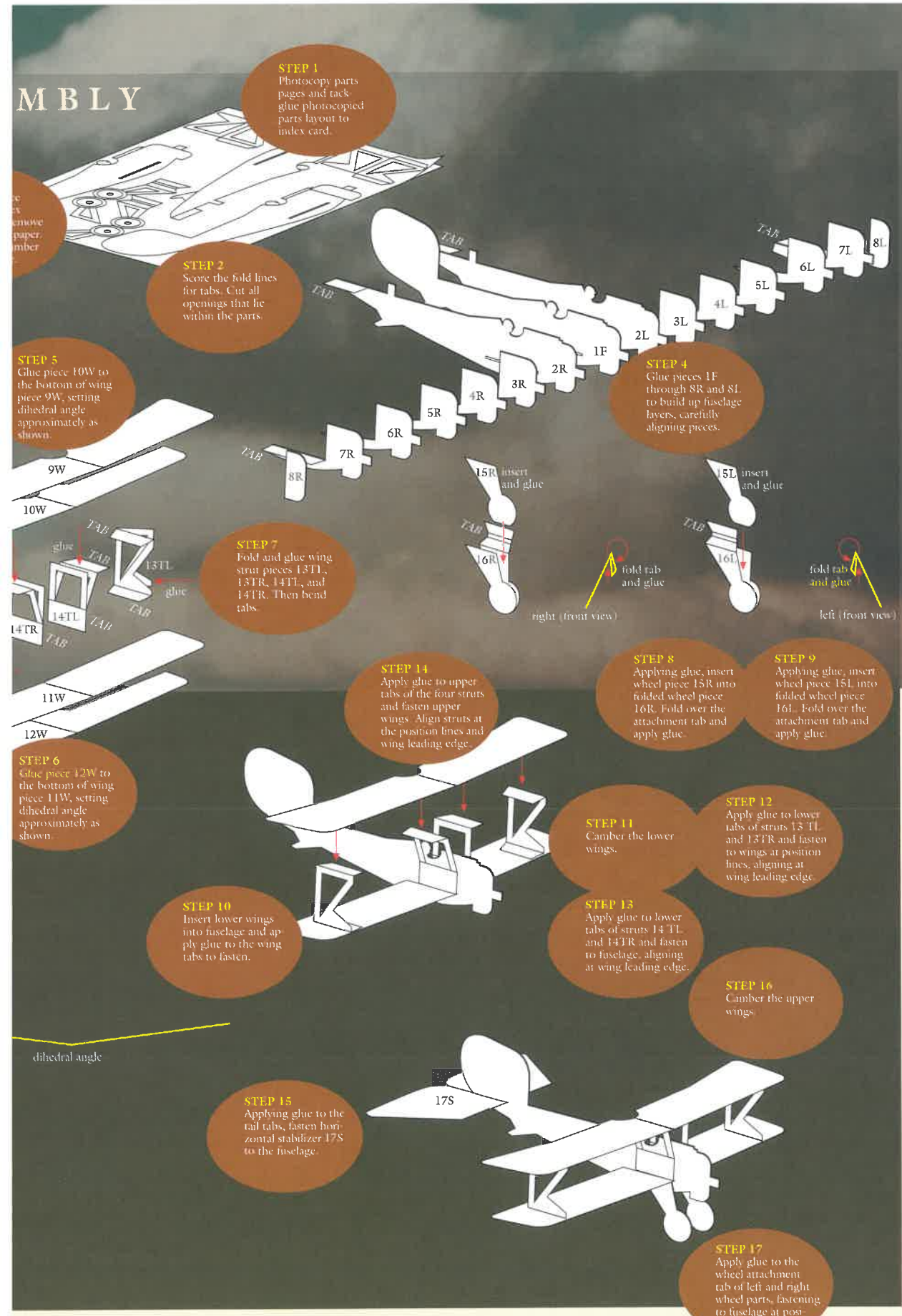
STEP 11
Camber the wings.

Albatros D.III

#3

[SEE TEXT p 12]

Year: 1917
Country of origin: Germany
Manufacturer: Albatros Werke
Type: Single-seat fighter
Engine: Mercedes 160 hp inline lic
Wing span: 29 ft 7 in (9 m)
Length: 24 ft (7.3 m)
Height: 9 ft 4 in (2.8 m)
Maximum Speed: 116 mph (186 k
Service Ceiling: 18,700 ft (5,610 n
Armament: 2 Spandau machine gu


STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.
STEP 4
Glue pieces 1F through 8R and 8L to build up fuselage layers, carefully aligning pieces.
STEP 5
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.
STEP 6
Glue piece 12W to the bottom of wing piece 11W, setting dihedral angle approximately as shown.
STEP 7
Fold and glue wing strut pieces 13TL, 13TR, 14TL, and 14TR. Then bend tabs.
STEP 8
Applying glue, insert wheel piece 15R into folded wheel piece 16R. Fold over the attachment tab and apply glue.
STEP 9
Applying glue, insert wheel piece 15L into folded wheel piece 16L. Fold over the attachment tab and apply glue.
STEP 10
Insert lower wings into fuselage and apply glue to the wing tabs to fasten.
STEP 11
Camber the lower wings.
STEP 12
Apply glue to lower tabs of struts 13TL and 13TR and fasten to wings at position lines, aligning at wing leading edge.
STEP 13
Apply glue to lower tabs of struts 14TL and 14TR and fasten to fuselage, aligning at wing leading edge.
STEP 14
Apply glue to upper tabs of the four struts and fasten upper wings. Align struts at the position lines and wing leading edge.
STEP 15
Applying glue to the tail tabs, fasten horizontal stabilizer 17S to the fuselage.
STEP 16
Camber the upper wings.
STEP 17
Apply glue to the wheel attachment tab of left and right wheel parts, fastening to fuselage at position lines.
TAB
glue
fold tab and glue
insert and glue
right (front view)
left (front view)
dihedral angle
1F
2L
3L
4L
5L
6L
7L
8L
2R
3R
4R
5R
6R
7R
8R
9W
10W
11W
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13TL
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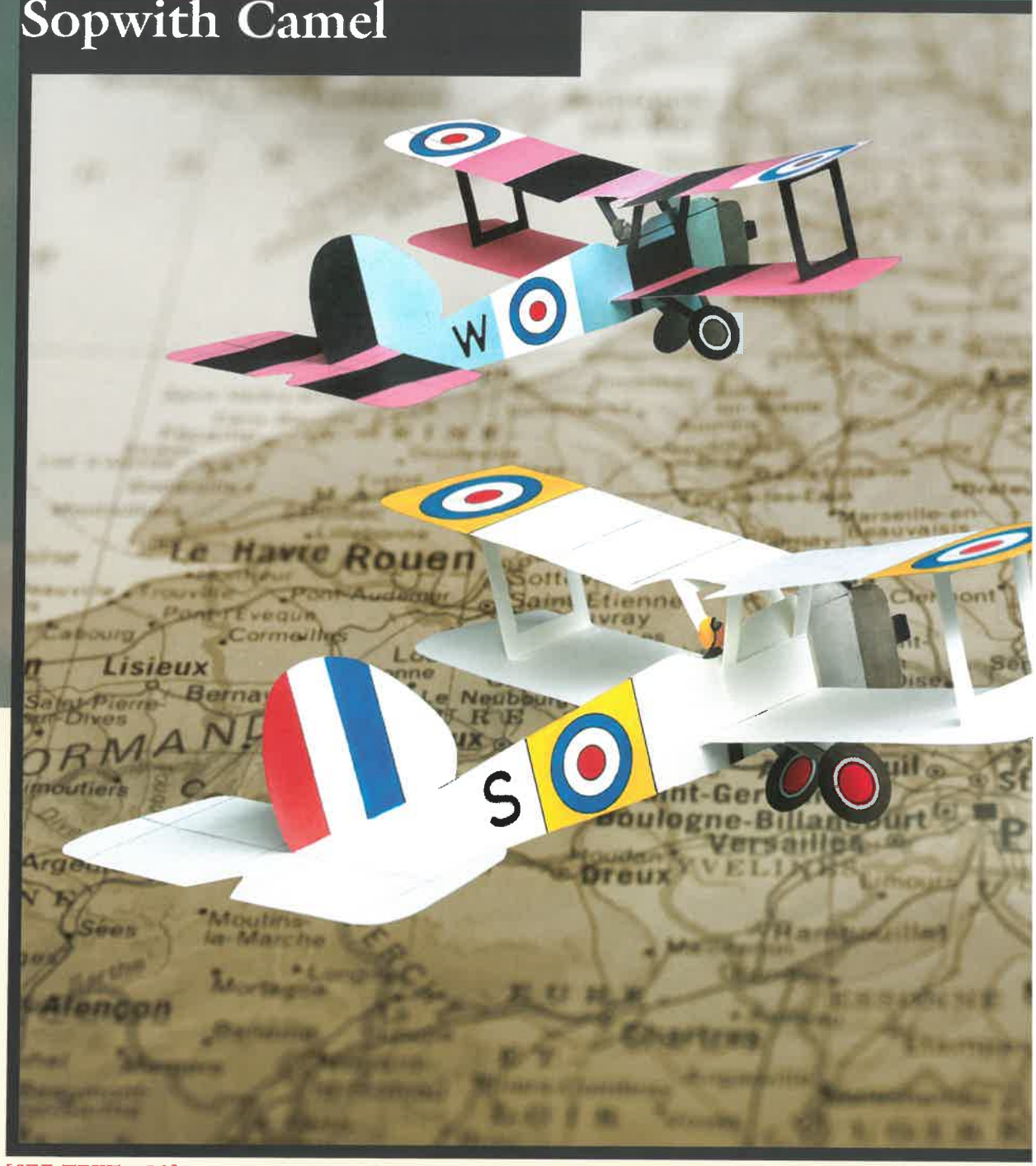
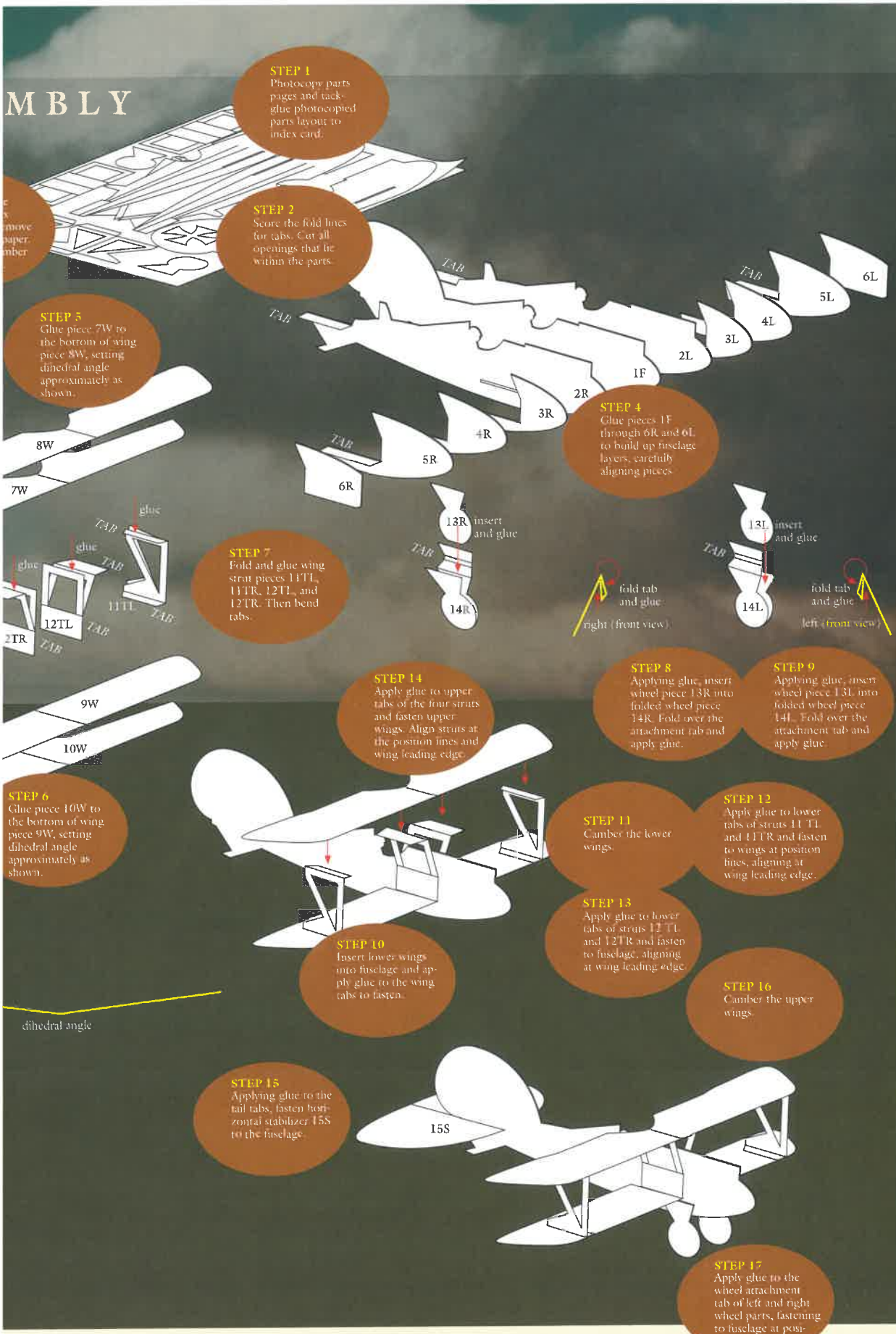
15R
16R
15L
16L
17S

#4 Sopwith Camel



[SEE TEXT p 13]

Year: 1917
Country of origin: Great Britain
Manufacturer: Sopwith
Type: Single-seat fighter
Engine: Bentley BR-1 150 hp air c
Wing span: 28 ft (8.4 m)
Length: 18 ft 8 in (5.1 m)
Height: 8 ft 6 in (2.5 m)
Maximum Speed: 118 mph (189 k
Service Ceiling: 19,000 ft. (5,700 r
Endurance: 2.5 hrs
Armament: 2 Vickers .303 machine


STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.
STEP 3
Glue piece 7W to the bottom of wing piece 8W, setting dihedral angle approximately as shown.
STEP 4
Glue pieces 1F through 6R and 6L to build up fuselage layers, carefully aligning pieces.
STEP 5
Glue piece 9W to the bottom of wing piece 10W, setting dihedral angle approximately as shown.
STEP 6
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.
STEP 7
Fold and glue wing strut pieces 11TL, 11TR, 12TL, and 12TR. Then bend tabs.
STEP 8
Applying glue, insert wheel piece 13R into folded wheel piece 14R. Fold over the attachment tab and apply glue.
STEP 9
Applying glue, insert wheel piece 13L into folded wheel piece 14L. Fold over the attachment tab and apply glue.
STEP 10
Insert lower wings into fuselage and apply glue to the wing tabs to fasten.
STEP 11
Camber the lower wings.
STEP 12
Apply glue to lower tabs of struts 11TL and 11TR and fasten to wings at position lines, aligning at wing leading edge.
STEP 13
Apply glue to lower tabs of struts 12TL and 12TR and fasten to fuselage, aligning at wing leading edge.
STEP 14
Apply glue to upper tabs of the four struts and fasten upper wings. Align struts at the position lines and wing leading edge.
STEP 15
Applying glue to the tail tabs, fasten horizontal stabilizer 15S to the fuselage.
STEP 16
Camber the upper wings.
STEP 17
Apply glue to the wheel attachment tab of left and right wheel parts, fastening to fuselage at position lines.
TAB
glue
insert and glue
fold tab and glue
right (front view)
left (front view)
dihedral angle
1F
2L
3L
4L
5L
6L
2R
3R
4R
5R
6R
7W
8W
9W
10W
11TL
11TR
12TL
12TR
13R
13L
14R
14L
15S

Spad XIII

#5

[SEE TEXT p 13]

Year: 1917
Country of origin: France
Manufacturer: Societe pour Aviatio
Type: Single-seat fighter
Engine: Hispano-Suiza 150 hp liqu
Wing span: 25 ft 6 in (7.7 m)
Length: 20 ft 1 in (6.1 m)
Height: 7 ft (2.1 m)
Maximum Speed: 119 mph (192 kr
Service Ceiling: 18,000 ft. (5,485 n
Range: 185 miles (298 km)
Armament: 2 Vickers machine guns

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.

STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 4
Glue pieces 1F through 8R and 8L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.

STEP 6
Glue piece 12W to the bottom of wing piece 11W, setting dihedral angle approximately as shown.

STEP 7
Fold and glue wing strut pieces 13TL, 13TR, 14TL, and 14TR. Then bend tabs.

STEP 8
Applying glue, insert wheel piece 15R into folded wheel piece 16R. Fold over the attachment tab and apply glue.

STEP 9
Applying glue, insert wheel piece 15L into folded wheel piece 16L. Fold over the attachment tab and apply glue.

STEP 10
Insert lower wings into fuselage and apply glue to the wing tabs to fasten.

STEP 11
Camber the lower wings.

STEP 12
Apply glue to lower tabs of struts 13TL and 13TR and fasten to wings at position lines, aligning at wing leading edge.

STEP 13
Apply glue to lower tabs of struts 14TL and 14TR and fasten to fuselage, aligning at wing leading edge.

STEP 14
Apply glue to upper tabs of the four struts and fasten upper wings. Align struts at the position lines and wing leading edge.

STEP 15
Applying glue to the tail tabs, fasten horizontal stabilizer 17S to the fuselage.

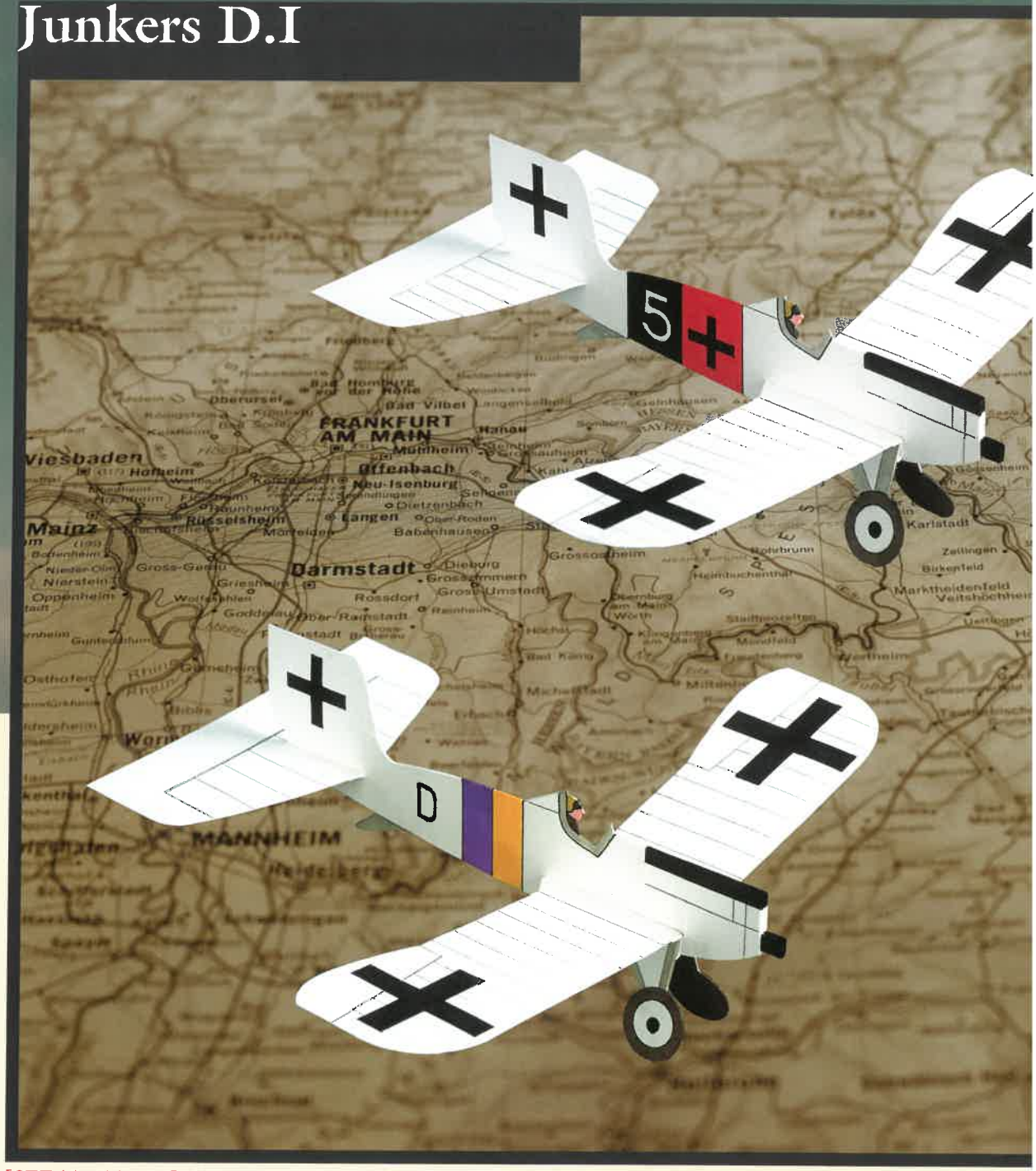
STEP 16
Camber the upper wings.

STEP 17
Apply glue to the wheel attachment tab of left and right wheel parts, fastening to fuselage at position lines.

TAB
glue
insert and glue
fold tab and glue
right (front view)
left (front view)
dihedral angle

#6

Junkers D.I



[SEE TEXT p 14]

Year: 1918
Country of origin: Germany
Manufacturer: Junkers
Type: Single-seat fighter
Engine: Mercedes 180 hp liquid co
Wing span: 29 ft 6 in (8.9 m)
Length: 23 ft 9 in (7.2 m)
Height: 7 ft 4 in (2.2 m)
Maximum Speed: 118 mph (189 kr
Service Ceiling: 18,000 ft. (5,485 n
Armament: 2 Spandau machine gur

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.

STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 4
Glue pieces 1F through 8R and 8L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.

STEP 6
Glue piece 12W to the bottom of wing piece 11W, setting dihedral angle approximately as shown.

STEP 7
Fold and glue wing strut pieces 13TL, 13TR, 14TL, and 14TR. Then bend tabs.

STEP 8
Applying glue, insert wheel piece 15R into folded wheel piece 16R. Fold over the attachment tab and apply glue.

STEP 9
Applying glue, insert wheel piece 15L into folded wheel piece 16L. Fold over the attachment tab and apply glue.

STEP 10
Insert lower wings into fuselage and apply glue to the wing tabs to fasten.

STEP 11
Camber the lower wings.

STEP 12
Apply glue to lower tabs of struts 13TL and 13TR and fasten to wings at position lines, aligning at wing leading edge.

STEP 13
Apply glue to lower tabs of struts 14TL and 14TR and fasten to fuselage, aligning at wing leading edge.

STEP 14
Apply glue to upper tabs of the four struts and fasten upper wings. Align struts at the position lines and wing leading edge.

STEP 15
Applying glue to the tail tabs, fasten horizontal stabilizer 17S to the fuselage.

STEP 16
Camber the upper wings.

STEP 17
Apply glue to the wheel attachment base of left and right wheel parts, fastening to fuselage at position lines.

weight of cooling liquid and radiators, air cooled engines had a better power-to-weight ratio, but to their disadvantage, their power-to-drag ratio was poor because of the large area the circle of cylinders exposed to the airstream. On the other hand, liquid cooled engines, with cylinders in a line, although heavier, allowed for a much narrower more streamlined nose in the airplane, which was desirable for high-speed flight. To their disadvantage, however, for fighter application these engines were more vulnerable to damage from enemy fire because any loss of cooling liquid from a damaged radiator rendered them useless. Both were used in World War I and would continue to be used.

In the search for greater speed it was learned that the less air was disturbed as it flowed across external surfaces the more efficient the airframe, improving the power-to-drag ratio. To reduce turbulance all drag-producing components had to be tucked away beneath a smooth skin. Cockpits needed to be completely enclosed; for speed, wings were made slimmer in profile and needed to be smoothly fared into the fuselage. And if the undercarriage could be completely fared, or better yet, be retracted into the fuselage or wings after takeoff, a tremendous reduction of drag in flight could be attained and as a result speed increased. The fact that thin wings designed for speed did not perform well in slow flight introduced a new challenge to landing. To solve this problem and reduce landing speeds, wing flaps were added to the back, or trailing edges, of the wings. These could be adjusted downward, thereby generating more lift during slow flight, making landings safer.

One person working on improving airplane performance for the race course in the 1930s was the American, Howard Hughes. In September of 1935 he completed his H-1 racer. Although it had a radial engine, drag was greatly reduced by designing a specially fitting cowl to enclose the engine (standard for all high speed airplanes having such engines in the future).

The airframe of the H-1 racer had flush-rivered highly polished sheet aluminum skins, flapped wings, and retractable undercarriage to further reduce drag. Even screw heads were carefully aligned with the airstream so that nothing created unnecessary drag. With this airplane Howard Hughes set the world speed record at 352 miles per hour (560 km/h), an astonishing feat when the average automobile crept along at about 40 mph (65 km/h). It was approximately three times the speed of the average World War I fighter. The H-1 was a trend setter, foreshadowing the shape airplanes would take from that point onward.

Applying the same design

DISPLAYING T
MODELS

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Wheels

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showing; their whee
only for landing and
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certain variants of s
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– various Messersch
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However, the model
with them attached
purposes, if desired.
pictures show them

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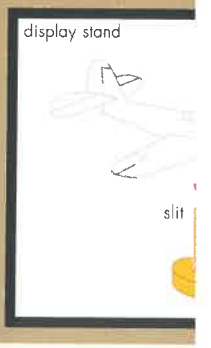
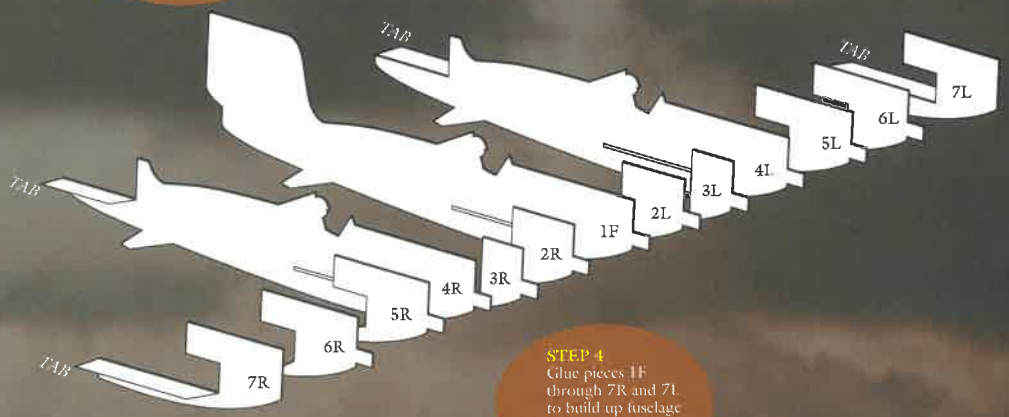


MBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.

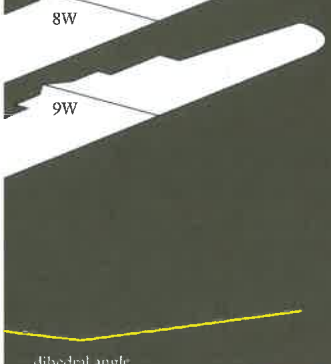
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

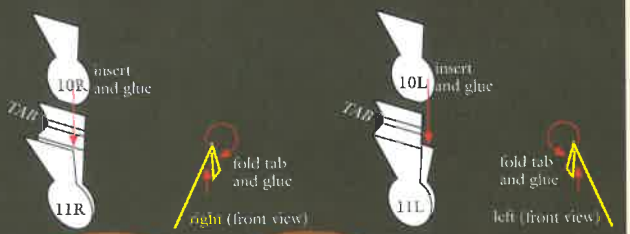
STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.



STEP 4
Glue pieces 1F through 7R and 7L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 9W to the bottom of wing piece 8W, setting dihedral angle approximately as shown.

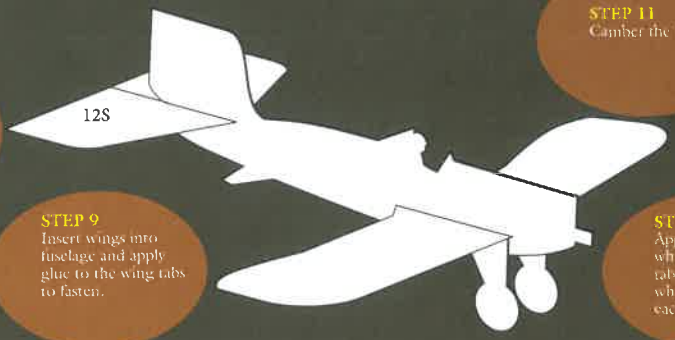




STEP 6
Applying glue, insert wheel piece 10R into folded wheel piece 11R. Fold over the attachment tab and apply glue.

STEP 7
Applying glue, insert wheel piece 10L into folded wheel piece 11L. Fold over the attachment tab and apply glue.

STEP 8
Applying glue to the tail tabs, fasten horizontal stabilizer 12S to the fuselage.



STEP 9
Insert wings into fuselage and apply glue to the wing tabs to fasten.

STEP 10
Apply glue to the wheel attachment tab of left and right wheel parts, fastening each to fuselage.

STEP 11
Camber the wings.

One reason the Nazis made such rapid territorial gains was due to their adoption of a new form of battle known as blitzkrieg (lightning war) in which air power was a key ingredient. The German Luftwaffe (air force) had a variety of first class aircraft with airplanes especially designed for ground attack, such as the Junkers Ju 87 dive bomber. It supplied firepower alongside front-line ground units so the line kept moving forward. The technique had been introduced in the previous war, but the new aspect was mobility. Blitzkrieg was all about speed and surprise – troops advancing rapidly and establishing strongholds in captured territory.

The United States did not enter the war immediately, but being an industrial giant, did supply military equipment to the embattled European Allies. One airplane among its early exports was the Curtiss P-36 Hawk. As war clouds gathered, the US Army Air Corp had ordered this plane for service in 1938 for its own defensive fleet. Like the Hughes racer, the Hawk was designed according to the new all-metal monoplane standard, a modern cantilevered low-mounted flapped design powered by an air cooled radial engine, developed from a long line of Curtiss biplane fighters. Exported, the P-36 was in use with both the French and English air forces when the war began. It was superior to its biplane predecessors, but was no match for the adversaries it met in the European skies.

At that time the Curtiss company was already experimenting with a more powerful replacement engine for the P-36, an Allison in-line liquid cooled powerplant. The use of this narrower engine, delivering 1160 horsepower with a supercharger, together with some other improvements to the Hawk airframe, turned it into an entirely new streamlined fighter designated the P-40 Warhawk [MODEL #7 p 36]. (In service with the Royal Air Force it was called the Tomahawk and later versions were called the Kittyhawk.) For cooling the engine, it had a chin radiator, giving it a distinctive and aggressive look. It was the first American fighter capable of speeds over 300 mph (483 km). Cantilevered wings were found to be strong enough to support the weight of extra equipment, therefore the P-40 had its guns mounted inside the wings. Maximizing this capability, for the first time six guns were installed. Potency increased dramatically. In the future firing through the propeller was mostly abandoned in favor of wing mountings.

Interestingly, the P-40 was already obsolete before it went into service. Although its airframe was basically satisfactory, its performance had not met expectations. One of the problems was that the engine's supercharger failed to provide the necessary oxygen

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or a back saw, cut a
dowel. Clamp the
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a slit wide enough
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xt, drill a hole the
as the dowel in the
ll block of wood,
e base of the stand.
tand, using white
lower end of the
hole drilled in the
sure the dowel
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a model its fuselage
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ter of gravity and
y friction. If several
played together,
t the dowel of each
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spend them by
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principles found on this and other racers to other more practical airplanes, aviation in general made great strides forward. For the first time reliable all-metal monoplane utility and passenger planes were built in the mid-1930s. Among them airliners such as the venerable Douglas DC-3 and the Boeing S-307 established commercial air routes that spanned continents and crossed oceans. This initiated the modern air age. The stage was set for a new breed of fighters to appear.

World War II

The war to end all wars had not lived up to its claim. There were again rumors of war in Europe, with similar issues at stake. Since the military benefits of air power had been clearly demonstrated in the previous war, Germany's Nazi (nationalist) government was keen to develop fast and powerful monoplanes for military use because their visions of empire included taking over other sovereign states by force. They were soon mass producing first class monoplane fighters and bombers, even though the Treaty of Versailles peace agreement signed at the end of World War I had forbidden it.

Fascist Italy supported the Nazi cause because it, too, had visions of empire and on the far side of the globe Imperial Japan had expansionist dreams. These aggressor states, together with others who sided with them, were known as the Axis forces. The nations against whom these forces were directed, together with others who sided with them, were known as the Allies. The most powerful of these were England together with the entire British Commonwealth, the United States of America, and Russia together with the whole of the Soviet Union.

As Axis nations began to mobilize, leaders of the Allied countries began to worry that their military preparedness was insufficient. This would be the first war in which air power was as important as any other means of mechanized warfare. A manufacturing race was once again on, with the Axis powers having a head start. When by the late 1930s war seemed imminent the Allies urged airplane manufacturers to begin work on improved military aircraft of all kinds, especially fighters, which could provide front-line defense.

Hostilities began in September of 1939 when the Nazis invaded Poland. By the end of 1940 much of continental Europe had been overrun. Only Great Britain resisted invasion. After the Battle of Britain Germany abandoned its western march and turned its attention to Russia. The Allies, under Britain's lead, began the slow and difficult task of driving the aggressors out of the captured regions. Russia also resisted invasion, and after 1941 began to slowly drive the Germans back.

for combustion in the thin air of high altitude. But with war escalating in Europe the dire need for aircraft precluded any further development. It went into production in 1939 as a replacement for the obsolete P-36 with the largest order for warplanes in US history to that date, due to orders also coming from England and France. However, not anticipating immediate entry into war itself, the US Army did not call upon other manufacturers to accelerate production at that time, so the P-40 was the only mass-produced fighter in the US arsenal and was also the only model available for export. Before the French planes were shipped that country had already fallen to the German Blitz and the whole order was diverted to England. Later Russia, too, received a shipment of P-40s.

On some battlefronts these P-40s bore the brunt of the action in the early months of the war. Fortunately the planes' shortcomings were more than compensated for by the P-40 airframe that could tolerate a lot of abuse and battle damage, which was much appreciated by its pilots. Being a relatively simple machine, this airplane was easily maintained in a battle-ready state. On the battlefield it also proved adaptable to either fighter or attack modes. Later versions were fitted with British Rolls Royce Merlin engines, which performed better at high altitude. For these reasons the Curtiss P-40 remained in production until almost the end of the war with 15,000 aircraft delivered.

The Curtiss P-40 is, perhaps, best remembered because of the planes of the Flying Tigers squadron. Their P-40s were emblazened with a memorable fierce-looking tiger shark mouth on the radiator. This independent squadron consisted of American civilians who had volunteered their services to help the Chinese defend themselves against Japanese invaders before either Japan or the United States had officially declared war. Later they were absorbed into the regular US military. The shark's mouth has since appeared on a variety of war planes.

German airplane designer, Willy Messerschmitt, set the standard of fighter design when he developed the Messerschmitt Bf 109. [MODEL #8 p 38] This standard stood until the advent of jet propulsion. The prototype first flew in 1935, the same year Howard Hughes set the record for speed. Various combinations of guns and cannon were tested. During World War II all other designers tried to come up with machines that could outperform the Bf 109, which they eventually did.

The Messerschmitt was a cantilevered low-mounted monoplane with a flapped wing design that allowed for high speed flight without at the same time increasing landing speed. The fuselage was of

revolutionary all-metal monocoque construction, and it had a retractable undercarriage. Power came from a 1400 horsepower Daimler-Benz inline liquid cooled supercharged engine. It was in every respect a thoroughly modern and efficient aircraft. Its one weakness was the narrow track of the main wheels, which led to difficult ground handling. The Bf 109 proved its effectiveness during the Spanish Civil War in 1936. Its principle weapon was a 30 mm rapid firing cannon inside the propeller hub, with a variety of other wing and fuselage mounted guns available in various models. Maximum speed was 386 mph (620 km/h) with an operational ceiling of 38,500 feet (11,700 m). In World War II Germany was prepared to take on all comers with this fighter. It outclassed anything the Allies launched against it at the beginning of the war, and saw service on all fronts throughout the war. Although it was used for numerous defensive and attack operations, it remained first and foremost a fighter. Some 33,000 were built, the second largest number of any one type.

In the late 1930s when the threat of war was increasing the British company, Supermarine, began developing a floatplane racer into a fighter, called the Spitfire. [MODEL #9 p 40] It became operational in 1938 and quickly gained a reputation as a first class machine with its powerful supercharged Rolls Royce Merlin engine, superb handling and maneuverability, good firepower, and its fine lines. It easily outclassed other British fighters (such as the Hawker Hurricane and the imported Tomahawk) and was the only Allied fighter to closely match the performance of the Messerschmitt Bf 109. When the German Luftwaffe began its aerial campaign in the Battle of Britain, not too many had yet been built. Despite this, and although greatly outnumbered, Royal Air Force fighters successfully defended the Island against invasion.

The designer of the Spitfire, R.J. Mitchell, created, arguably the most beautiful airplane of the entire war, with its smoothly fared fuselage and graceful elliptical wings. But its beauty was more than skin deep. Its speed was 374 mph (600 km/h) and its fighting strength came from either eight wing-mounted guns or two 20 mm cannon and four guns. Like its German rival, the Bf 109, it had a remarkable airframe which proved to make the Spitfire one of the most versatile and modified airplanes of the war. Its performance was continually improved, evolving through more than a dozen variants, some designed for highly specialized tasks, including a high altitude interceptor version with a pressurized cockpit. The Spit, as it was affectionately called, had a long and illustrious career, serving for the duration of the war and beyond. It was also manufac-

tured for as long as the war lasted and was still in service as a carrier-based version in 1967.

In 1940, as country after country fell under the advance of the Nazi Blitz, Great Britain called on the Americans to increase airplane production to bolster beleaguered Allied forces. They needed a more powerful and faster fighter to be completed in only 120 days. The North American company rose to the challenge to produce the **P-51 Mustang.** **[MODEL #10 p 42]** The airframe of this fighter was designed to maximize speed. Its wings had a new profile shape over which the airflow remained smooth (called laminar flow). Despite this, at first the plane did not meet British expectations. The problem again lay with the Allison engine. Like the engine used in the P-40, it did not operate well at altitude, making the plane unacceptable for air-to-air combat. At first the plane's use was limited to ground attack. But the P-51 was transformed when fitted with the British Merlin engine. After the end of 1941, when the United States joined the war, the Mustang became one of the most effective fighters.

The "new" P-51 was good not only for aerial combat, but also for long range escort of the heavy bombers when fitted with droppable auxilliary fuel tanks. This plane could accompany them on strategic bombing runs into the heart of the European continent, giving air cover against German fighter attacks all the way to industrial targets. Many believe this capability was a turning point in the war and helped to shorten the conflict. It certainly greatly reduced Allied bomber losses, especially those on the American daylight bombing runs. Several improvements were made to the airframe of this fighter, most notably the use of a bubble canopy, which gave pilots greatly improved visability. Later versions had a top speed of over 400 mph (700 km/h) and a service ceiling of over 40,000 feet (12000 m). The Mustang became the most-loved American fighter, and along with the Spitfire and the Messerschmitt, became the very symbol of air power during World War II.

Before the war the Russian military command had adopted tactics not unlike the German Blitzkrieg methods. For this the Ilyushin design bureau developed a multi-role airplane that operated best at low altitudes. The airplane was a low-mounted cantilevered wing monoplane with flaps, retractable undercarriage, and enclosed cockpit. It could be armed with a variety of fixed guns, heavy cannon, small loads of bombs, and rockets. The **Ilyushin Stormovik Il-2** **[MODEL #11 p 44]** assault airplane not only had varied armament but was heavily armor plated for protection against fire from any direction. Some versions had a gunner facing rearward to provide extra fire-

power in that direction. More Stormoviks were built than any other airplane of World War II – 36,000 in all. For this reason this airplane, more than fighters specialized for air-to-air combat, was responsible for the German defeat on the eastern front. It entered service just in time to meet the German invasion force entering Russia in 1941.

That year also saw the war spread beyond Europe when Japan attacked the United States. Japan had a centuries-old tradition of militarism in which the Samurai warrior class was held in high esteem. Conquest was a high ideal. In the 1930s this nation was caught between two eras: leaders who were oldstyle militarists, and a country becoming a modern industrialized state requiring raw materials for manufacture. This combination of old ways and new needs resulted in Japanese aggression against neighboring resource-rich countries long before there was any official declaration of war.

Traditionally naval power had been Japan's most important military asset. But the Japanese (along with other naval countries) recognized that flying machines and ships could operate effectively together and began to switch naval strength from battleships to aircraft carriers. These ships had storage space for airplanes below flat-topped decks on which airplanes could take off and land while the ship was at sea. This combination of ships and airplanes could effectively bring the combined strength of air power and naval power to any coastal location on earth and in December of 1941 the Japanese Navy made a surprise air attack on the United States naval base at Pearl Harbor, Hawaii, bringing both countries into the World War II conflict.

One airplane used as a carrier based fighter by the Japanese was the Mitsubishi A6M Zero. [MODEL #12 p 46] Because of the cramped quarters and limited runway space, carrier based fighters were traditionally small, with limited performance. The Zero was different. Although small, it was highly maneuverable, fast, and had range. The Zero could out-turn any other fighter, making it a formidible foe in air-to-air combat. Its small airframe was fitted with a radial engine producing over 1000 horsepower, giving the plane an excellent weight-to-power ratio and a top speed in excess of 320 miles per hour (500 km/h). It carried a large supply of fuel internally, with the ability to carry additional fuel in a single drop tank, giving it a range of 1200 miles (1900 km). This made the Zero very effective for carrier operation out in the ocean where targets were often a long way off. In the attack on Pearl Harbor, for example, the ships were some 300 miles (480 km) at sea. This airplane went into service

in 1940 and became the first carrier-based airplane to match in performance land-based machines.

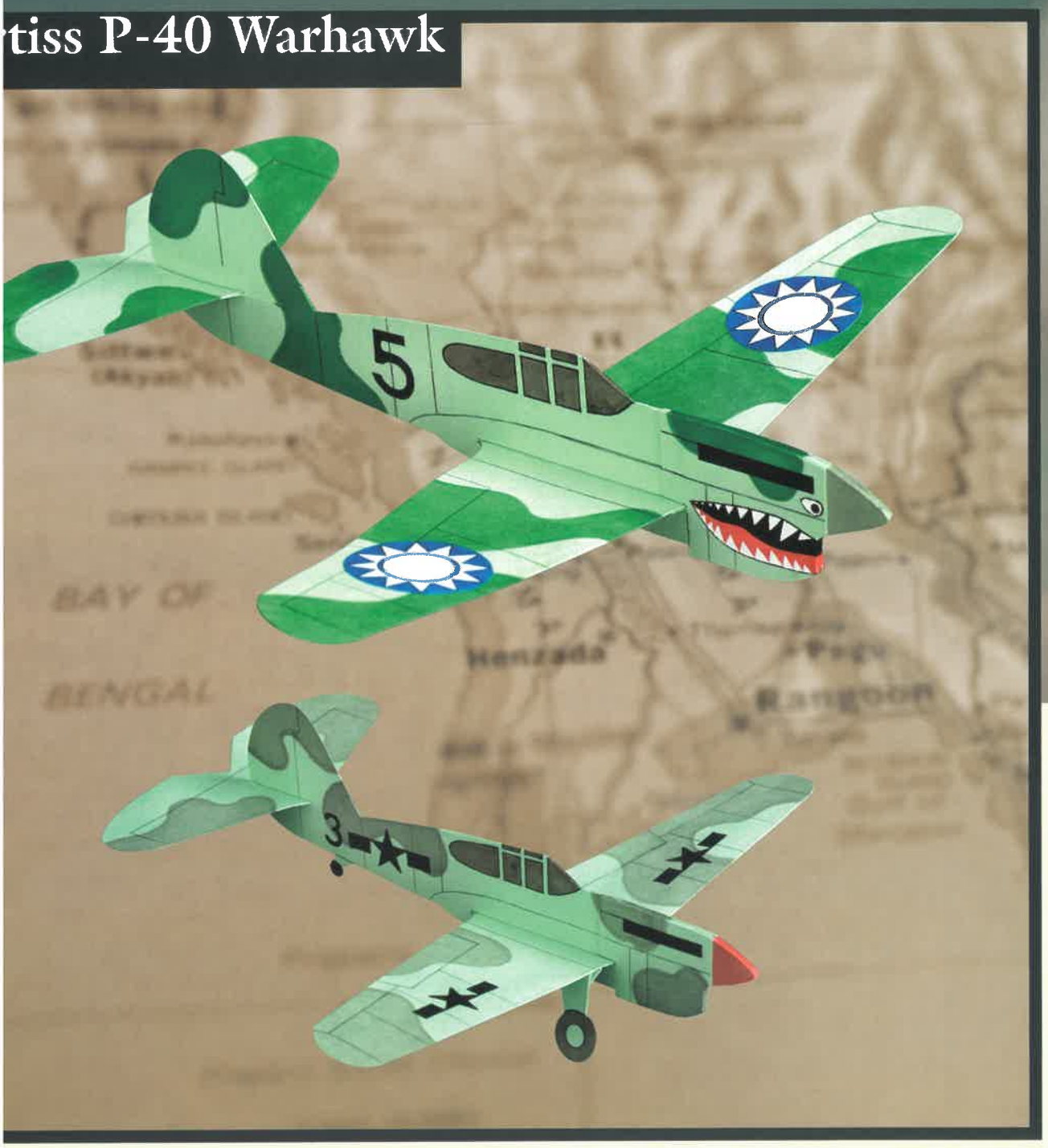
What gave the Zero its advantage was also its weakness. To keep its weight down, it had no fire-fighting equipment and no armor plating to protect its vital parts or its pilot. A fighter of equal performance had no difficulty bringing it down. When Allied forces deployed such fighters in large numbers after 1942, Zero success ended. However, at Pearl Harbor the Americans had no fighters flying cover that could match the performance of the Zeros. The obsolete American P-36s deployed there were not an effective defense. As a result 18 naval vessels and 170 aircraft were lost in the attack.

American industry was well suited to the production of quality machinery of all kinds, including airplanes. Lessons already learned in aerodynamics, airframe strength, armor, engine power output at different altitudes, and armament were now skillfully and swiftly applied. Within a year American aircraft manufacturers had already designed and built the prototypes for all the fighters that would eventually be produced for the war effort. These were aircraft of exceptional performance, easily matching that of any Axis machines. As the war escalated, production increased tremendously from about 2000 airplanes per year at the outset of the war, when P-40s were first shipped to Britain, to nearly 100,000 in the last year of the war, with a total wartime production of more than 300,000 machines in an array of different specialized types. This was by far the largest production of aircraft by any one country. Without these American-built machines giving the Allies air superiority, the outcome of the war might well have been different.

The war in the Pacific was largely a naval war in which aircraft carriers played a central role. Japan conquered enormous stretches of small islands in the South Pacific. Once Axis forces were defeated in Europe the Allies, under American lead, began to drive back the Japanese. A variety of American-built carrier-based fighters were introduced to battle the nimble Zero and other Japanese aircraft, such as the Grumman cat series and the Vought F4U Corsair [MODEL #13 p 48] Entering service in 1943, it completely dominated the Zero, achieving an 11 to 1 ratio of success. At first it was thought that such a large and fast machine might be unsuitable to take off and land on the cramped deck of a carrier, so it was introduced as a land based fighter. There were several concerns besides its size. Its cockpit was situated far back restricting visibility. This made carrier landings, a challenge at the best of times, even more difficult. Also, because it was big and heavy, the undercarriage was too stiff for

text continues on p

tiss P-40 Warhawk



XT p 30]

Year: 1938
Country of origin: United States of America
Manufacturer: Curtiss
Type: single-seat fighter/fighter-bomber
Engine: one 1160 hp Allison, 12 cylinder, Vee, liquid cooled, supercharger
Wing span: 37 ft 4 in (11.4 m)
Length: 33 ft 4 in (10.2 m)
Height: 12 ft 4 in (3.8 m)
Maximum speed: 343 mph (552 km/h)
Service ceiling: 30,000 ft (9,144 m)
Range: 750 miles (1,207 km)
Armament: six 0.5 in Browning machine-guns, three external 500 lb bombs

ASSEMBLY

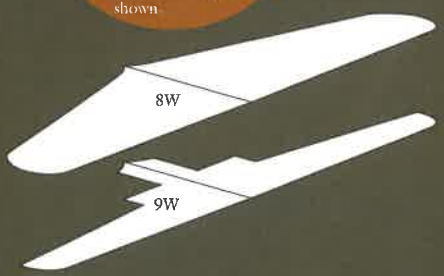
STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.

STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.

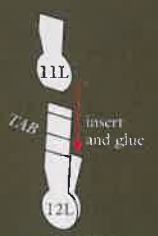
STEP 4
Glue pieces 1F through 7R and 7L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 9W to the bottom of wing piece 8W, setting dihedral angle approximately as shown.



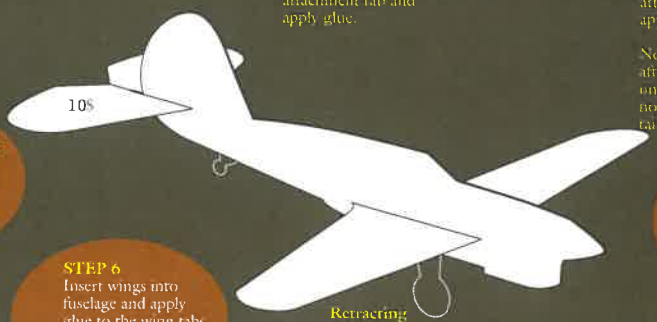
dihedral angle

OPTIONAL
Applying glue, insert wheel piece 11R into folded wheel piece 12R. Fold over the attachment tab and apply glue.



OPTIONAL
Applying glue, insert wheel piece 11L into folded wheel piece 12L. Fold over the attachment tab and apply glue.

Note: Fighters built after WWII had tricycle undercarriages having a nose wheel instead of a tailwheel.



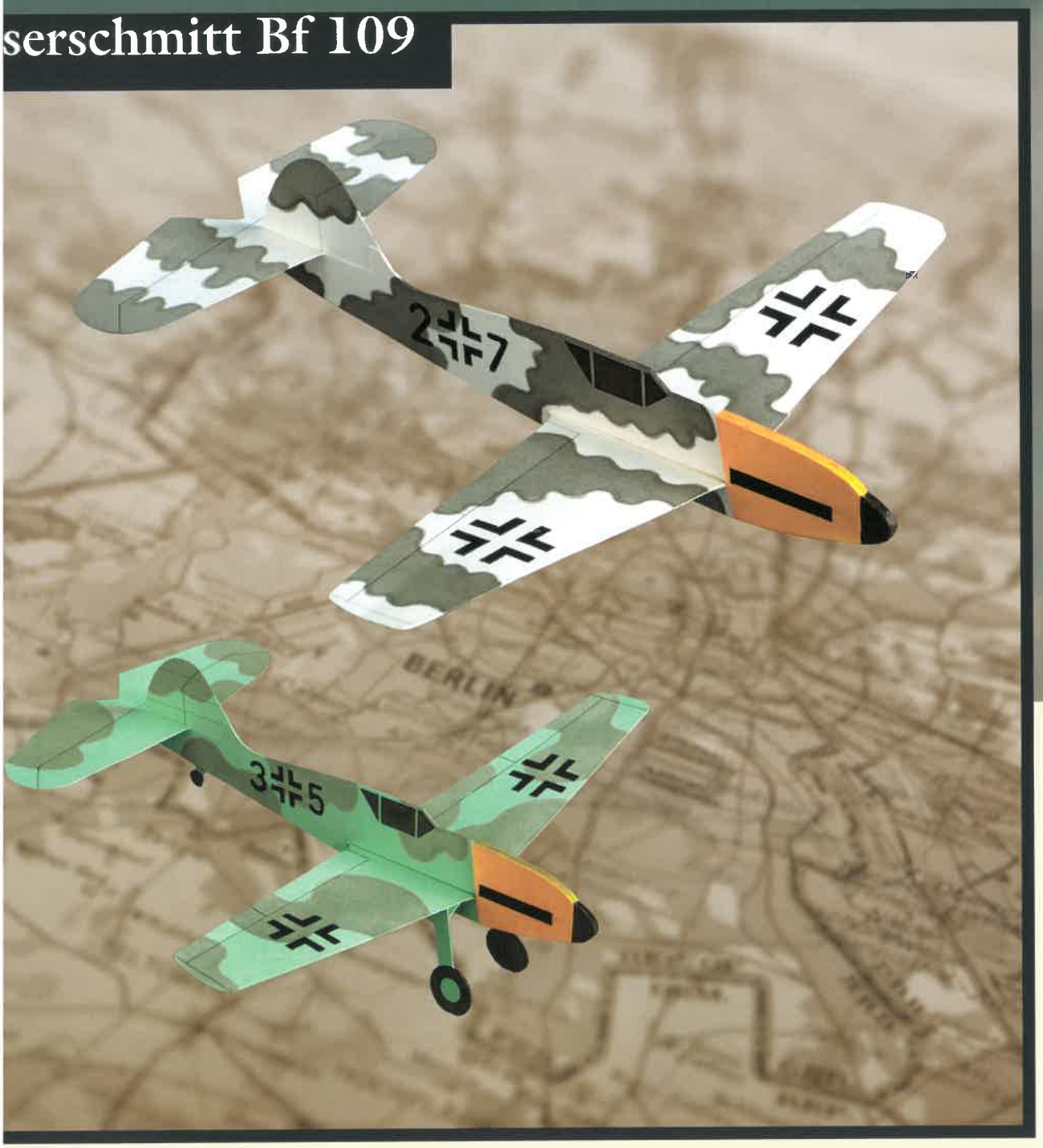
STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 10S to the fuselage.

STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

Retracting undercarriage (if used, attach to wings at position lines)

STEP 8
Camber t

serschmitt Bf 109



[TEXT p 31]

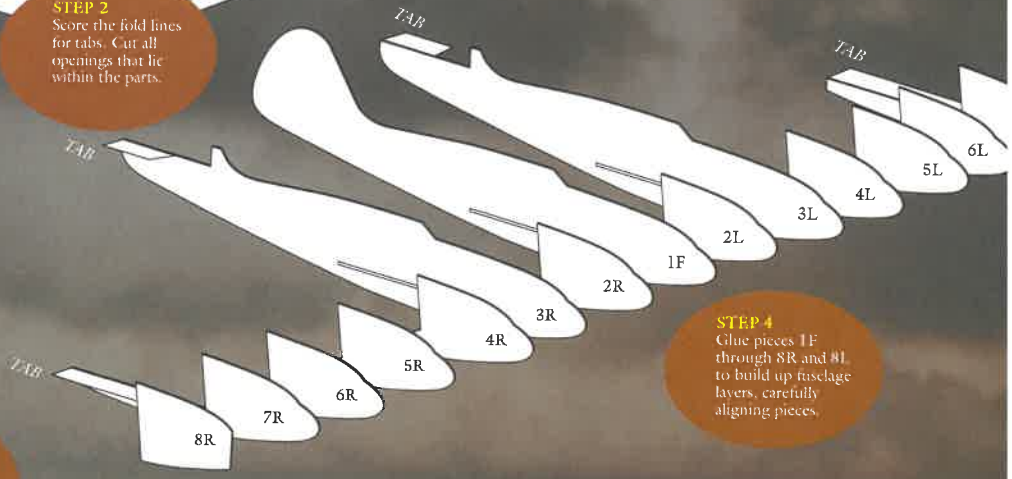
Year: 1935
Country of origin: Germany
Manufacturer: Messerschmitt
Type: single-seat fighter/fighter-bomber
Engine: one 1400 hp Daimler-Benz, inline, liquid cooled, supercharger
Wing span: 32 ft 7 in (9.9 m)
Length: 29 ft 7 in (9 m)
Height: 11 ft 2 in (3.4 m)
Maximum speed: 386 mph (623 km/h)
Service ceiling: 38,500 ft (11,750 m)
Range: 450 miles (725 km)
Armament: 2 cowl-mounted 7.92 mm machine guns, 1 hub-firing 30 mm cannon, 2 wing-mounted 20 mm cannon

ASSEMBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.

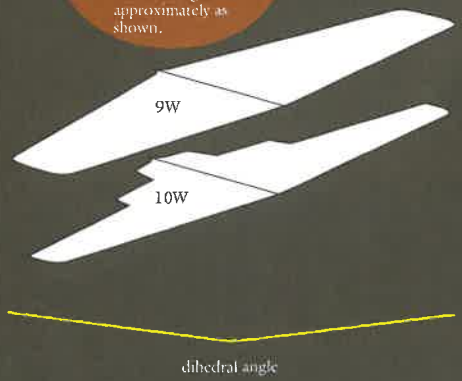
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.



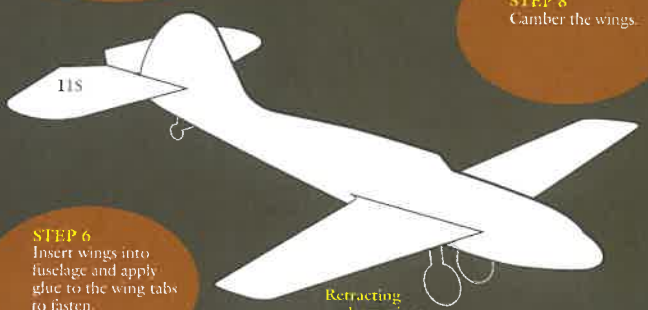
STEP 4
Glue pieces 1F through 8R and 8L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.



STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 11S to the fuselage.

STEP 8
Camber the wings.

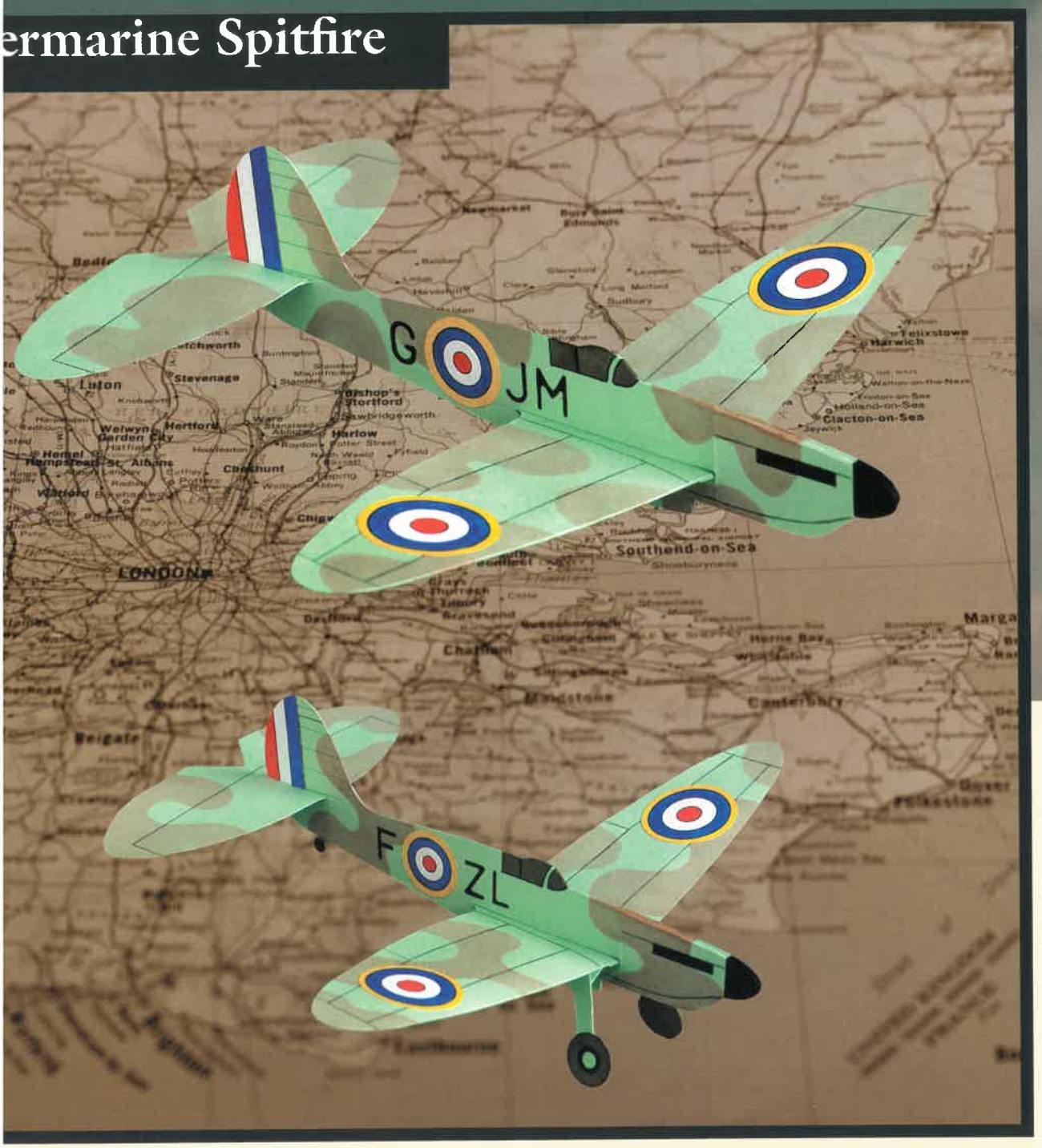


STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

Retracting undercarriage (if used, attach to wings at position lines)

SEE P37 FOR ASSEMBLY

ermarine Spitfire

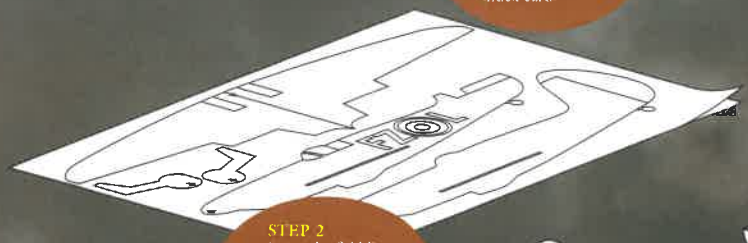


XT p 32]

Year: 1938
Country of origin: Great Britain
Manufacturer: Supermarine
Type: single-seat fighter/fighter-bomber
Engine: one 1440 hp Rolls-Royce Merlin, 12 cylinder, Vee, liquid cooled, supercharger
Wing span: 36 ft 10 in (11.2 m)
Length: 29 ft 11 in (9.1 m)
Height: 11 ft 5 in (3.5 m)
Maximum speed: 374 mph (602 km/h)
Service ceiling: 37,000 ft (11,280 m)
Range: 470 miles (756 km)
Armament: two 20 mm cannon and four .303 machine guns in the wings or no cannon and 8 machine guns

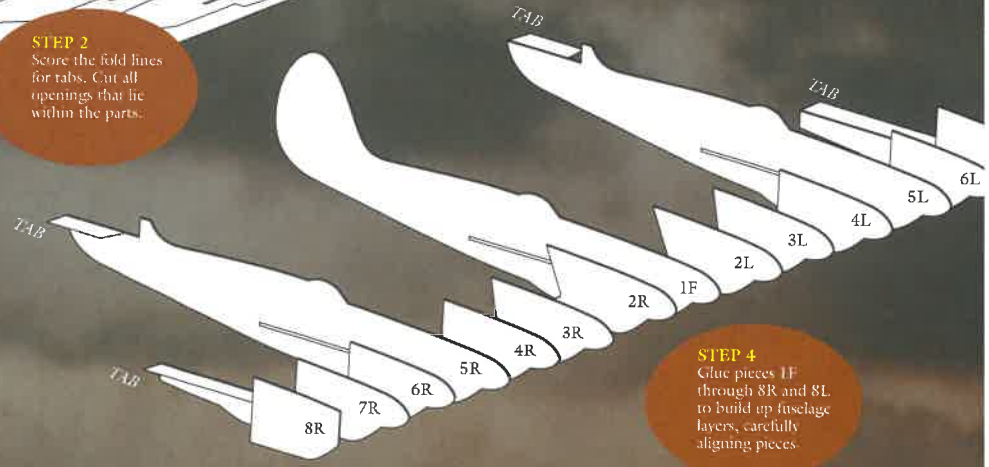
ASSEMBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.



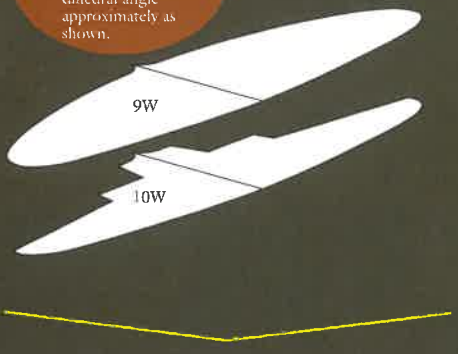
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.



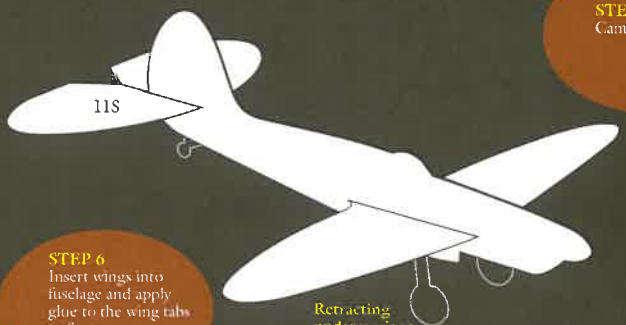
STEP 4
Glue pieces 1F through 8R and 8L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.



dihedral angle

STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 11S to the fuselage.



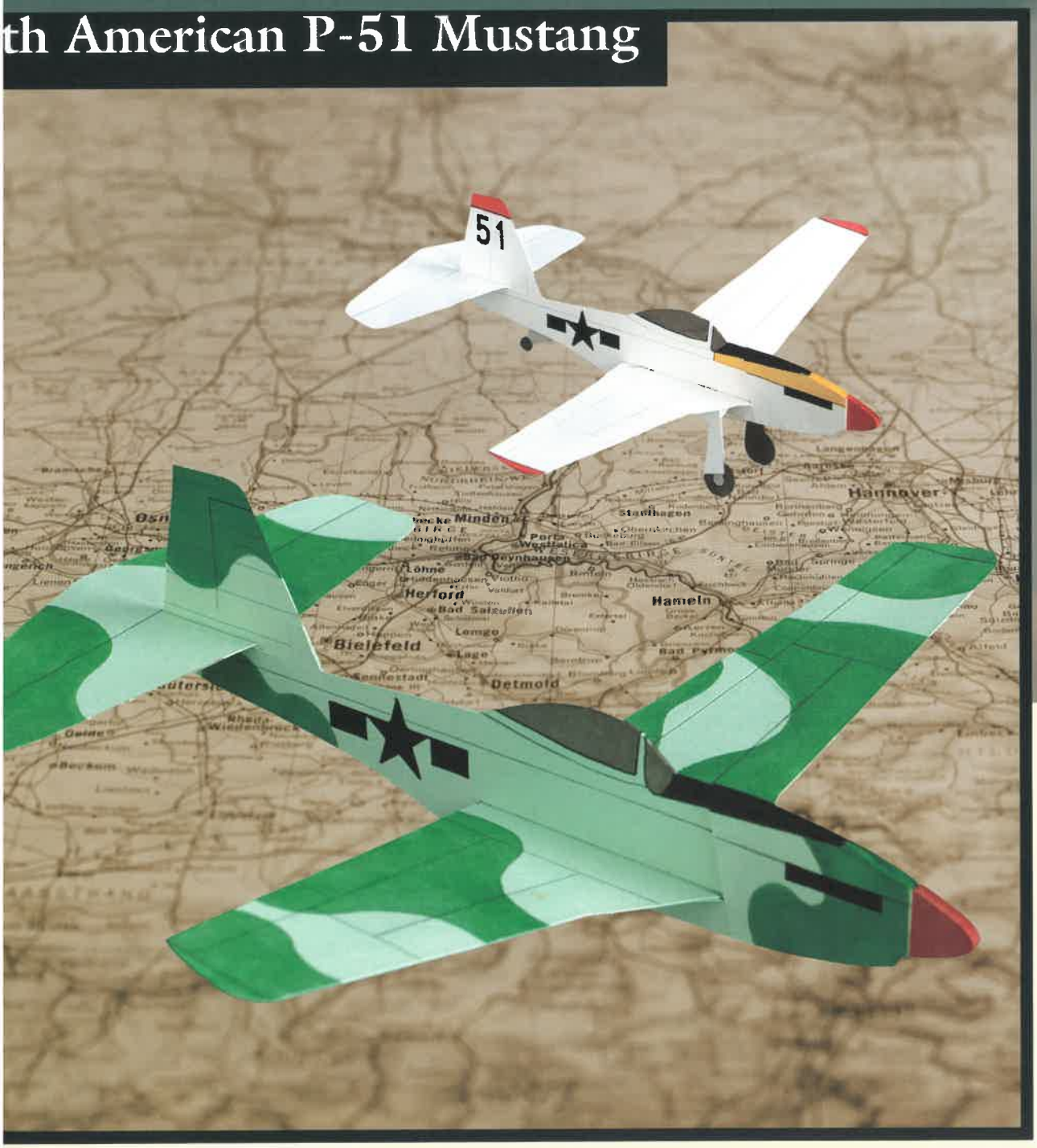
STEP 8
Camber the wings.

STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

Retracting undercarriage (if used, attach to wings at position lines)

SEE P37 FOR ASSEMBLY

th American P-51 Mustang

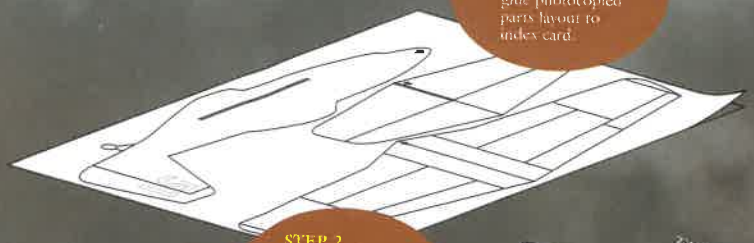


[T p 33]

Year: 1942
Country of origin: United States of America
Manufacturer: North American
Type: single-seat fighter/fighter-bomber
Engine: one 1490 hp Rolls-Royce Merlin, 12 cylinder, Vee, liquid cooled, supercharger
Wing span: 37 ft (11.2 m)
Length: 32 ft 3 in (9.9 m)
Height: 12 ft 2 in (3.7 m)
Maximum Speed: 437 mph (704 km/h)
Service Ceiling: 42,000 ft (12,800 m)
Range: 2,080 miles (3,347 km)
Armament: six 50 calibre machine-guns, two external 1000 lb bombs or six rockets

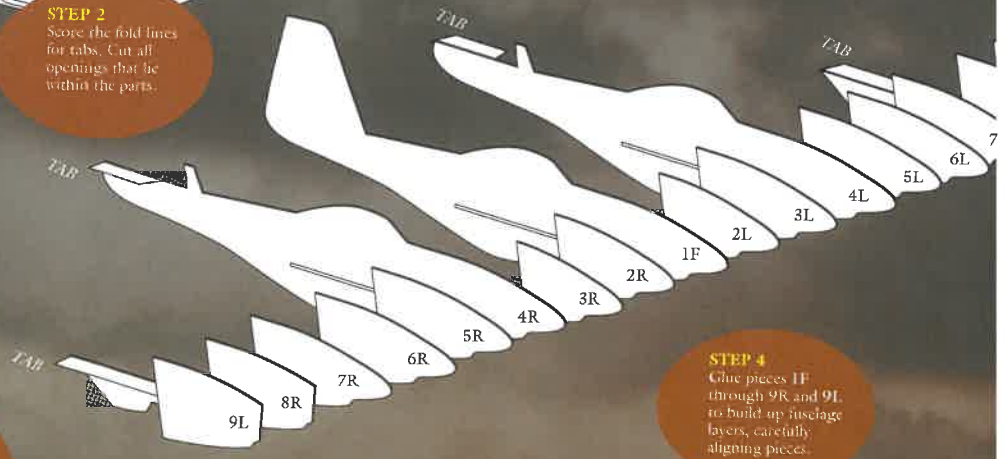
ASSEMBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.



STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.



STEP 4
Glue pieces 1F through 9R and 9L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 11W to the bottom of wing piece 10W, setting dihedral angle approximately as shown.

STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 12S to the fuselage.

STEP 8
Camber the wings.

STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

Retracting undercarriage (if used, attach to wings at position lines)

SEE P37 FOR ASSEMBLY

shin Stormovik Il-2

XT p 33]

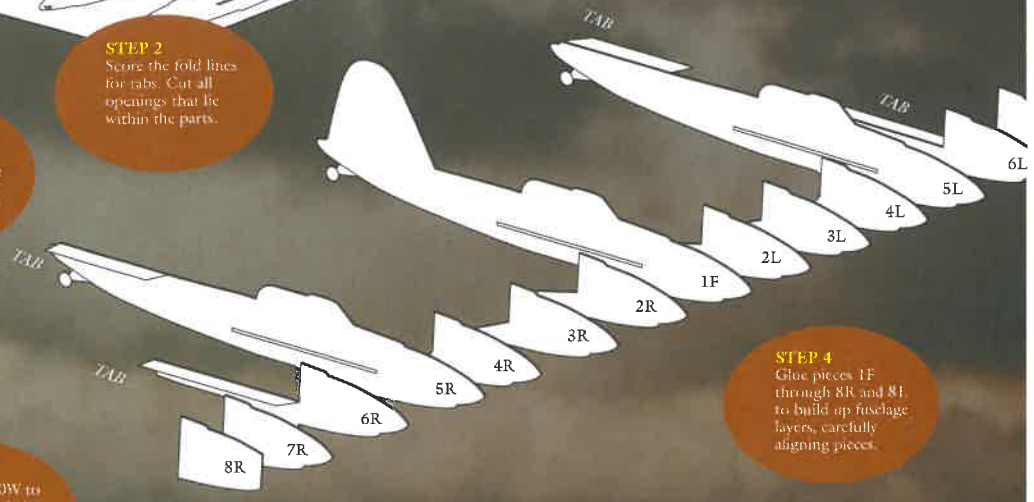
Year: 1941
Country of origin: Russia
Manufacturer: Ilyushin
Type: two-seat ground attack
Engine: one 1770 hp inline liquid cooled piston
Wing span: 48 ft (14.6 m)
Length: 38 ft (11.6 m)
Height: 11 ft 1 in (3.4 m)
Maximum Speed: 251 mph (404 km/h)
Service Ceiling: 20,000 ft (6,000 m)
Range: 373 miles (600 km)
Armament: two forward-firing 23 mm cannon, two forward-firing and rearward-facing machine guns, and up to 1,321 lb (600 kg) wing-mounted bombs or rockets

ASSEMBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.

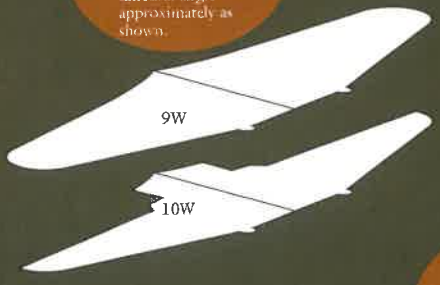
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.



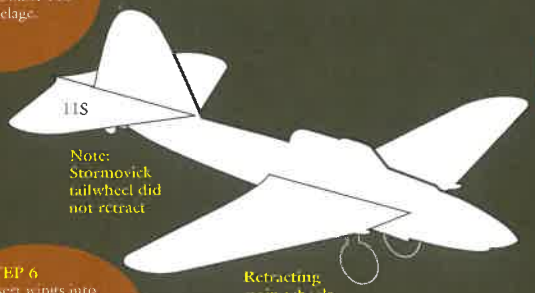
STEP 4
Glue pieces 1F through 8R and 8L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.



dihedral angle

STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 11S to the fuselage.



Note: Stormovick tailwheel did not retract

STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

STEP 8
Camber the wing

Retracting main wheels (if used, attach to wings at position lines)

SEE P37 FOR ASSEMBLY

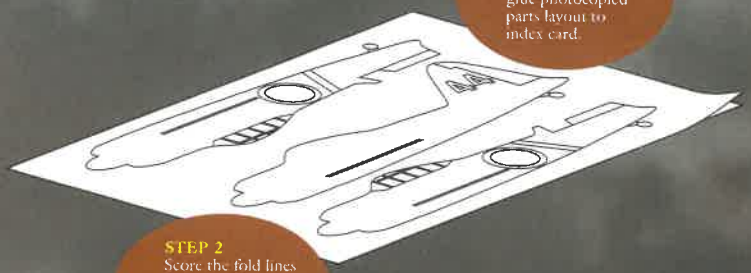
zubishi A6M Zero

[T p 34]

Year: 1940
Country of origin: Japan
Manufacturer: Mitsubishi
Type: single-seat fighter/fighter-bomber
Engine: one 1100 hp Nakajima air-cooled radial, supercharger
Wing span: 36 ft 1 in (11 m)
Length: 29 ft 11 in (9.1 m)
Height: 11 ft 6 in (3.5 m)
Maximum speed: 351 mph (565 km/h)
Service ceiling: 38,500 ft (11,740 m)
Range: 1200 miles (1,900 km)
Armament: two nose-mounted machine guns, two wing-mounted cannon, two 500 lb (230 kg) underwing bombs

ASSEMBLY

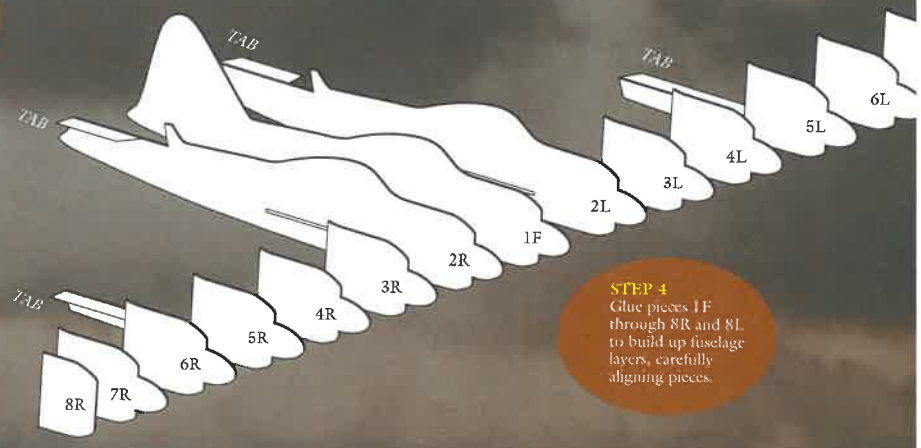
STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.



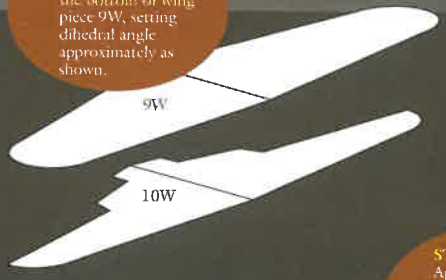
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.

STEP 4
Glue pieces 1F through 8R and 8L to build up fuselage layers, carefully aligning pieces.

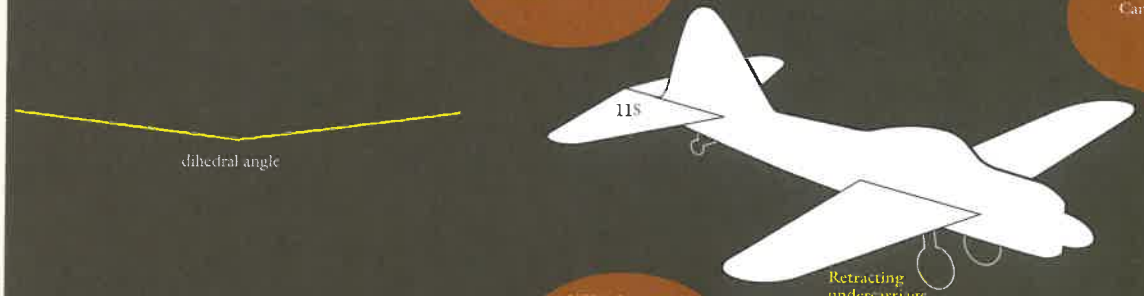


STEP 5
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.



STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 11S to the fuselage.

STEP 8
Camber the wings.



STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

Retracting undercarriage (if used, attach to wings at position lines)

SEE P37 FOR ASSEMBLY

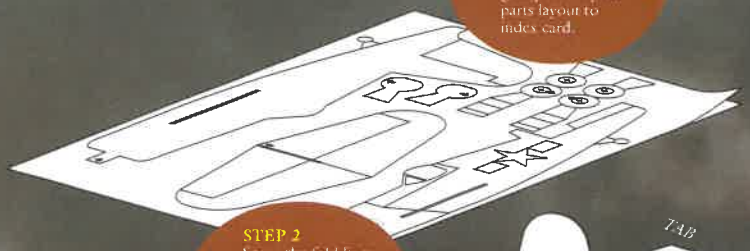
ght F4U Corsair

XT p 35]

Year: 1943
Country of origin: United States of America
Manufacturer: Chance-Vought
Type: single-seat fighter
Engine: one 2000 hp Pratt & Whitney air cooled radial piston, supercharger
Wing span: 41 ft (12.5 m)
Length: 33 ft 4 in (10.2 m)
Height: 16 ft 1 in (4.9 m)
Maximum Speed: 417 mph (671 km/h)
Service Ceiling: 37,000 ft (11,000 m)
Range: 1,015 miles (1,633 km)
Armament: six 50 caliber wing-mounted machine-guns or four 20 mm cannon

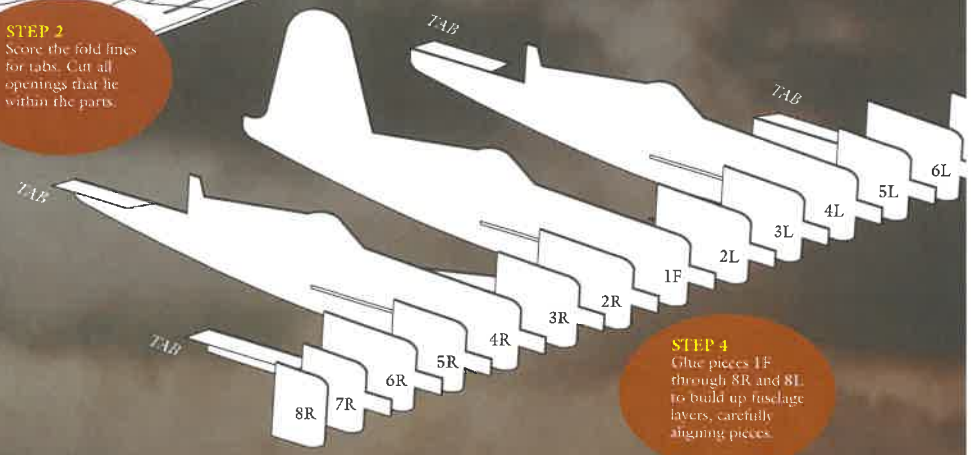
ASSEMBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.



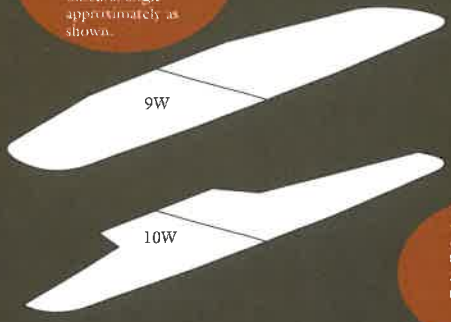
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.



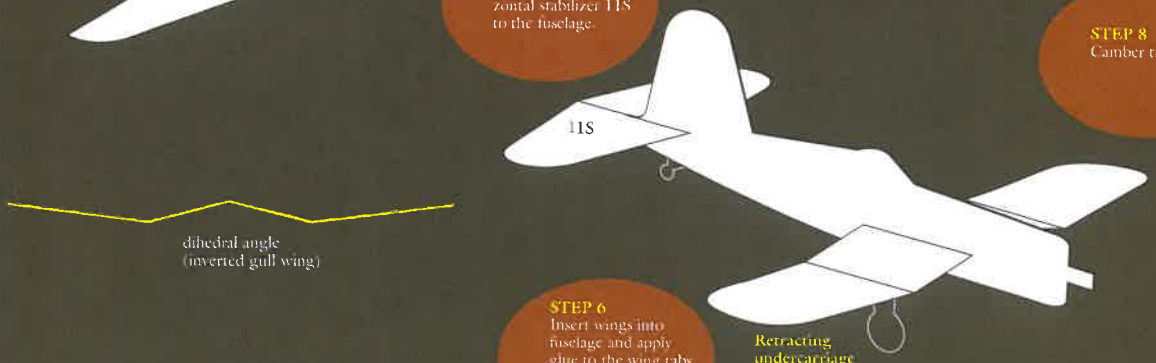
STEP 4
Glue pieces 1F through 8R and 8L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.



STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 11S to the fuselage.

STEP 8
Camber the wings.



STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

Retracting undercarriage (if used, attach to wings at position lines)

SEE P37 FOR ASSEMBLY

smooth carrier landings, where arrester cables were needed to bring landing aircraft to a halt. But these problems were not insurmountable, as the British proved, who first operated Corsairs from a carrier. The United States followed suit, with great success.

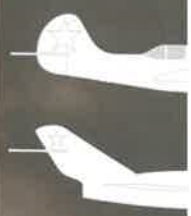
The inverted gull-wing Corsair had a distinctive look. These wings were needed to provide sufficient ground clearance for its large-diameter propeller during takeoff. Its radial engine produced 2000 horsepower making it the first American plane to attain 400 mph (640 km) in level flight. Its armor plating provided good protection for its vital parts, and it was heavily armed with four rapid-firing 20 mm cannon. These factors gave the Corsair total domination of the skies. But despite American air superiority the island war was not easily won. The vast naval distances made it difficult to move troops and supplies. Despite heavy naval losses, Japan surrendered only after two atomic bombs were dropped by American heavy bombers in the summer of 1945, bringing World War II to an end.

After World War II

When prosperity returned after the war, airlines, begun before the war, resumed operations and air travel for business and pleasure increased rapidly. The aviation industry continued to develop new airplane types to meet the need, with advances in aerodynamic research during the war having set the stage for a new class of airplane suited to fly non-stop transoceanic routes. But not all was peaceful. Before long the stalwart Corsair fighter was again called upon for wartime service, this time in Korea. The Korean War began on a June morning in 1950 when troops from North Korea entered the South, supported by 150 fighter planes. Aid for the North in the way of training and equipment came from China and Russia.

The Russian Revolution after World War I had put that country under Communist rule and it became the leader of a large block of countries – the Soviet Union. It gave aid to other like-minded governments. After World War II this totalitarian form of government spread across Eastern Europe and Asia, including China and North Korea. Many believed this was a threat to the freedoms recently hard won in World War II. To counter this aggression in Korea the United Nations, an organization established five years earlier to foster good relations between nations, sent armed forces from member countries to the region. The United States was a major contributor. The United States and Russia, allies in World War II, were now on opposite sides.

Aircraft of World War II vintage, like the Corsair, were used in Korea at first. Russia supplied various planes to the Communist North, including the



Yakovlev Yak-18, [MODEL #14 p 56] a versatile machine built for World War II pilot training by the Yakovlev design bureau. Many of these were converted by the North Koreans for ground attack against supply and fuel depots. The plane also served to train pilots for duty on the jet fighters just being introduced into service for the first time. Four Yak-18s counted among the victories of one American ace flying a Corsair. The lightweight maneuverable Yak-18 is still used for pilot training in Russia and for aerobatic displays there and in other countries.

In Korea, jets replaced piston-powered fighters. Turbojet engines were first developed in Germany and Great Britain during World War II. Airplanes with this new kind of propulsion saw limited combat with the Luftwaffe during the closing days of the war. After the war the United States and Russia also developed jet-powered airplanes. They required new skills by pilots and service crews alike to attain combat performance.

When a distinctive looking Russian-built jet fighter appeared in Korean skies towards the end of 1950, it created an immediate world-wide sensation; it introduced a new breed of fighter and surprised the UN forces by its performance. Unique were the steeply swept wings and forward located cockpit. Air intake for its jet engine was through a gaping round "mouth." This was the

Mikoyan-Gurevich MiG-15. [MODEL #15 p 58] It was originally designed as a high altitude interceptor for the defense of the Soviet Union against heavy bomber attack. Its swept-wing airframe was designed to operate at high speed and high altitude, over 50,000 feet (15000 m) with a top speed of just under the speed of sound in level flight but with supersonic dives. With this its designers believed the MiG-15 could out-climb, out-turn, and fly higher than anything flown by its opponents. These MiGs were used in Korea to counter UN bombers flying into the North but soon were engaging the escort fighters accompanying these heavily loaded aircraft. They performed well as air-to-air fighters through a wide range of altitudes. Ironically, in the first ever victory between jet fighters, occurring in November of that year, a MiG-15 fell victim to an older and much inferior American jet.

This uncomplicated and rugged machine was built in very large numbers – 8000 in Russia alone, plus many thousands in other Soviet countries. Some are still in active service.

The plane that the US developed at that time was the **North American F-86 Sabre.** [MODEL #16 p 60] It became the main opponent to the MiG-15, and had the same basic configuration. Advanced German aeronautical research data captured during World War II greatly influenced jet

development everywhere after the war. Therefore it is no surprise that the American and Russian jets were so similar. Their airframes were designed for supersonic flight, which they did regularly in a dive. The swept-wing Sabre was an all-around good airplane. Pilots spoke fondly of its superb flight characteristics as well as its combat performance. The Sabre had more graceful lines than the MiG-15 and according to some remains the most beautiful jet of all.

MiGs outnumbered Sabres. By the end of 1951 the Communists had more than 500 MiGs in service, and by the following summer they had doubled that number. Yet Sabre pilots gained the upper hand. They were better trained and better field service was provided for their machines. Electronic equipment was introduced, enhancing combat performance. The result was that, by the end of hostilities in the summer of 1953, 792 MiGs had been downed with only 78 Sabres lost, making for a 10 to 1 victory ratio. Sabres made many pilots into aces.

The Sabre went on to serve in the air forces of twenty countries, including Canada and Australia, with a total of 6,300 airplanes built in a variety of models, the most for any post-World War II American airplane. Some live on as research aircraft and along with many World War II airplanes, some Sabres and MiGs are also privately owned as sport "warbirds."

With the success of jet fighters, further research with turbojet engines led to the building of a variety of airplanes, military and civil, that took advantage of the simplicity, power, and durability of this type of propulsion. After the 1950s most airliners were turbojets and many smaller planes had turbojet engines driving ordinary propellers, called turboprops. More recently quieter and more fuel-efficient turbofans have also been developed. The power and efficiency of jet engines make rapid worldwide transportation possible.

Although hostilities came to an end in Korea, the threat of war with Communist forces in various places continued. The production of ever more powerful weaponry escalated into an "arms race" resulting in a world-wide standoff between Communists and those opposed to this form of government. The new strategy was deterence by preparedness; each side having the potential to strike first with equal or greater force than the other. This became the Cold War, in which intercontinental missiles and strategic bombers faced each other in large numbers across the globe. On both sides, this created a new category of fighter plane, the dedicated interceptor, to provide a front line defense against missile or bomber attack, on around-the-clock standby, ready to scramble at a

moment's notice. These planes were typically larger machines than previous fighters. They were also much faster, with top speeds exceeding the speed of sound in level flight, and with greater range. Throughout the 1950s, 60s, and 70s frequent new supersonic models were introduced, each flying faster, higher, and having more firepower than the previous model. Electronically guided armament became standard on interceptors. This new generation of jet fighters first saw action in Vietnam.

The Vietnam War did not begin suddenly. This country had endured many years of small skirmishes between various warring factions involving French colonial forces. In 1954 the country was divided into two political regions, North and South Vietnam, in an attempt to establish peace, but the French-supported government of the South was under constant threat of being overthrown by Northern independent forces. The United States began to give aid to their French allies. When French forces were defeated in a decisive battle, France withdrew completely from the region, leaving the Americans as the only foreign force helping the South. When the government in the South collapsed, the United States steadily increased the strength of its force in Vietnam to keep the North from gaining control. Furthermore, the increasing amount of aid North Vietnam was receiving from Communist neighbors was seen as a direct threat to world peace. In the winter of 1965 the Americans began strategic bombing of the North. Thus the conflict turned from a war between Vietnamese factions into one between Communists and Americans – a hotspot in the Cold War.

In 1958 during the "arms race" the American aircraft manufacturer, McDonnell Douglas, developed a new twin engined supersonic multi-role jet as a private venture, hoping to sell it to the government as an interceptor. The F-4 Phantom [MODEL #17 p 62] outperformed all other American fighters and after 1960 the United States military began to place orders for this machine.

Two large afterburning turbojet engines propelled the F-4 to a speed of more than twice the speed of sound – 1400 mph (2200 km/h). Its fuselage was designed to produce the least possible amount of drag during the transition from subsonic to supersonic speed. It could operate at altitudes over 60,000 feet (18000 m). The Phantom could carry a large variety of armament for either air-to-air or air-to-ground combat, suspended from pylons underneath the fuselage and wings – to a total of over 12,000 lbs (5,700 kg). The Phantom was the first fighter to have no fixed gun because it was believed that in supersonic combat a gun was ineffective, made obsolete by

guided missiles. When this was discovered to be false, gun and cannon pods were designed to go underneath. It was the first American fighter to have on-board electronics capable of identifying, intercepting, and destroying any target that was out of visual range but in range of its radar, without assistance from ground control. It was the first to have computers to control engine air intake to optimize performance under varying conditions. It was equally at home operating from land or off carriers at sea.

In the Vietnam War the Phantom proved its versatility by taking over most of the heavy fighting assignments alongside heavy bombers. American pilots flew Phantoms in large formations in bombing runs over the North as well as engaging various Russian- and Chinese-built fighters in air-to-air combat, in which they achieved 277 victories. The Phantom was also highly effective in close front-line air support for ground units. Overall its combat performance was so impressive that it was purchased for use in the air forces of many countries around the world. Undergoing steady improvement, it is still in active service. During the height of the Vietnam War 70 Phantoms per month were built. It has become the most popular fighter since World War II and until the end of the 20th century more Phantoms were in service at one time than any other aircraft, and next to the Sabre, the most numbers built. It remained in continuous production for 20 years – 1959-79. At one time both the US Air Force Thunderbirds and Navy Blue Angels used Phantoms for their aerial display machines. They are often referred to as "Phabulous Phantoms."

The last service these airplanes saw with the American forces was in the Gulf War of 1991, when Iraq invaded its neighbor, Kuwait. A United Nations coalition force was mounted to drive the aggressors out, which they did in less than two months. In that conflict the then 30-year-old Phantoms flew missions alongside more sophisticated machines, such as the Lockheed F-117 Nighthawk Stealth and the Panavia Tornado. [MODEL #18 p 64]

Both of these airplanes mark another turn in the development of the fighters, continuing where the Phantom left off in the use of electronics for operation. Besides its use of electronics, the Nighthawk airframe has a unique multi-faceted shape which makes it almost invisible to radar. But it does only one thing, attack, and operates only at night. The Tornado, on the other hand, is a supersonic multi-purpose fighter, interceptor, and attack airplane, but is not stealthy.

This airplane, too, has an interesting airframe. During slow flight its wings have almost no sweepback, but as speed is increased the wings

automatically sweep back more and more, controlled by its electronic flight system.

The development of this technology began in Germany with the very earliest jets. Sweepback helps maintain aircraft stability during high-speed flight in the transsonic and supersonic range.

The Tornado has two rapid-fire 27 mm cannon in the fuselage and can carry an array of air-to-air and air-to-ground missiles and bombs externally, up to 20,000 lb (9000 kg). The sophisticated on-board electronic navigation and weapon guidance systems requires a crew of two to operate. These systems are continually upgraded to the most advanced level. The swing wing design makes the airplane versatile, useful for low altitude slow-speed applications as well as high altitude supersonic ones. Three specialized variants exist: fighter, fighter-bomber, and electronic combat and reconnaissance.

An international feasability study into swing wing geometry began in the 1960s. Because Europeans did not want to rely solely on American airplanes for their defensive fleets, they saw this as opportunity to develop their own unique fighter. For this Great Britain, Germany, and Italy pooled their resources to form the Panavia company. Its prototype swing wing flew in 1974, in Germany, with production beginning in 1980. Each of the three countries assumed responsibility for a particular section of the plane. Production continued until 1998 with about 900 planes built.

Tornados served with the Royal Air Force in the Gulf War and participated in low-level daylight missions using laser guided bombs. This made them especially vulnerable to ground fire. One was lost on the very first run over an Iraqi airfield. Tornados also served more recently with peace keeping forces in the Balkans.

December 2003 marks the one hundredth anniversary of the invention of powered flight. The many and dreadful wars of the 20th century, with their extraordinary demands for machinery, resulted in the steady development of fighter airplanes. In this time they evolved from fragile kite-like machines from which pilots fired at each other from open cockpits with pistols and carbines, to supersonic machines launching guided missiles and bombs at targets beyond visual range. The trend of the 21st century is for the building of far fewer types of military planes having greater capabilities in a wide variety of roles with their construction being done by fewer but larger companies.

If good can come from war machines it is this: because fighters were always technologically advanced, they contributed to the steady and rapid improvement of all types of civil aircraft.

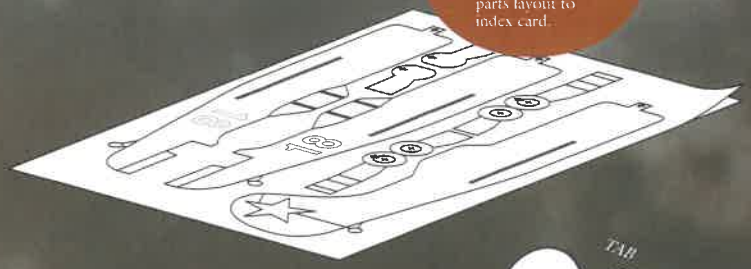
ovlev Yak-18

[T p 51]

Year: 1943
Country of origin: Russia
Manufacturer: Yakovlev
Type: two-seat trainer
Engine: one 5 cylinder 145 hp air cooled radial
Wing span: 33 ft 4 in (10.6 m)
Length: 27 ft 8 in (8.1 m)
Height: 10 ft 7 in (2.7 m)
Maximum speed: 160 mph (250 km/h)
Service ceiling: 17,000 ft (5,100 m)
Range: 450 miles (720 km)
Armament: none or various small bombs

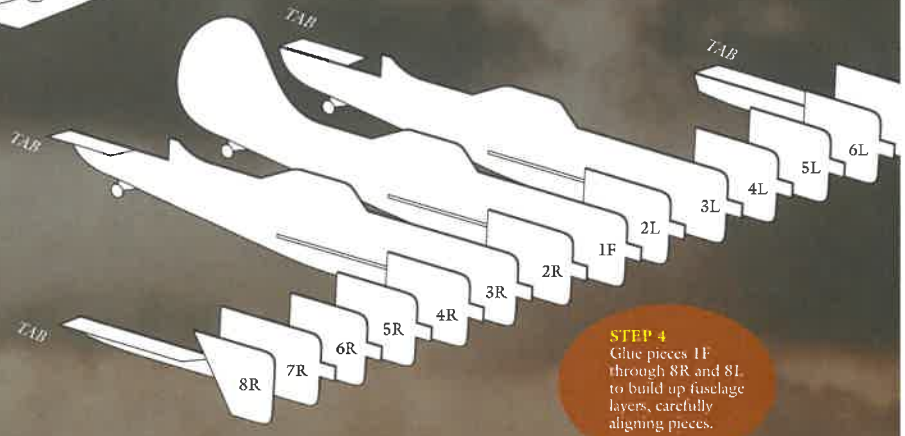
ASSEMBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.



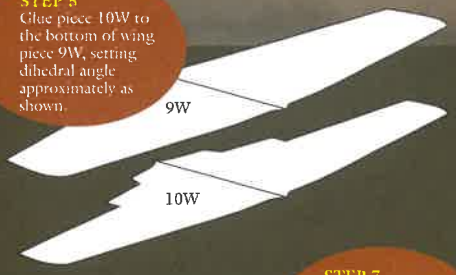
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.



STEP 4
Glue pieces 1F through 8R and 8L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 10W to the bottom of wing piece 9W, setting dihedral angle approximately as shown.



STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 11S to the fuselage.

STEP 8
Camber the wings.

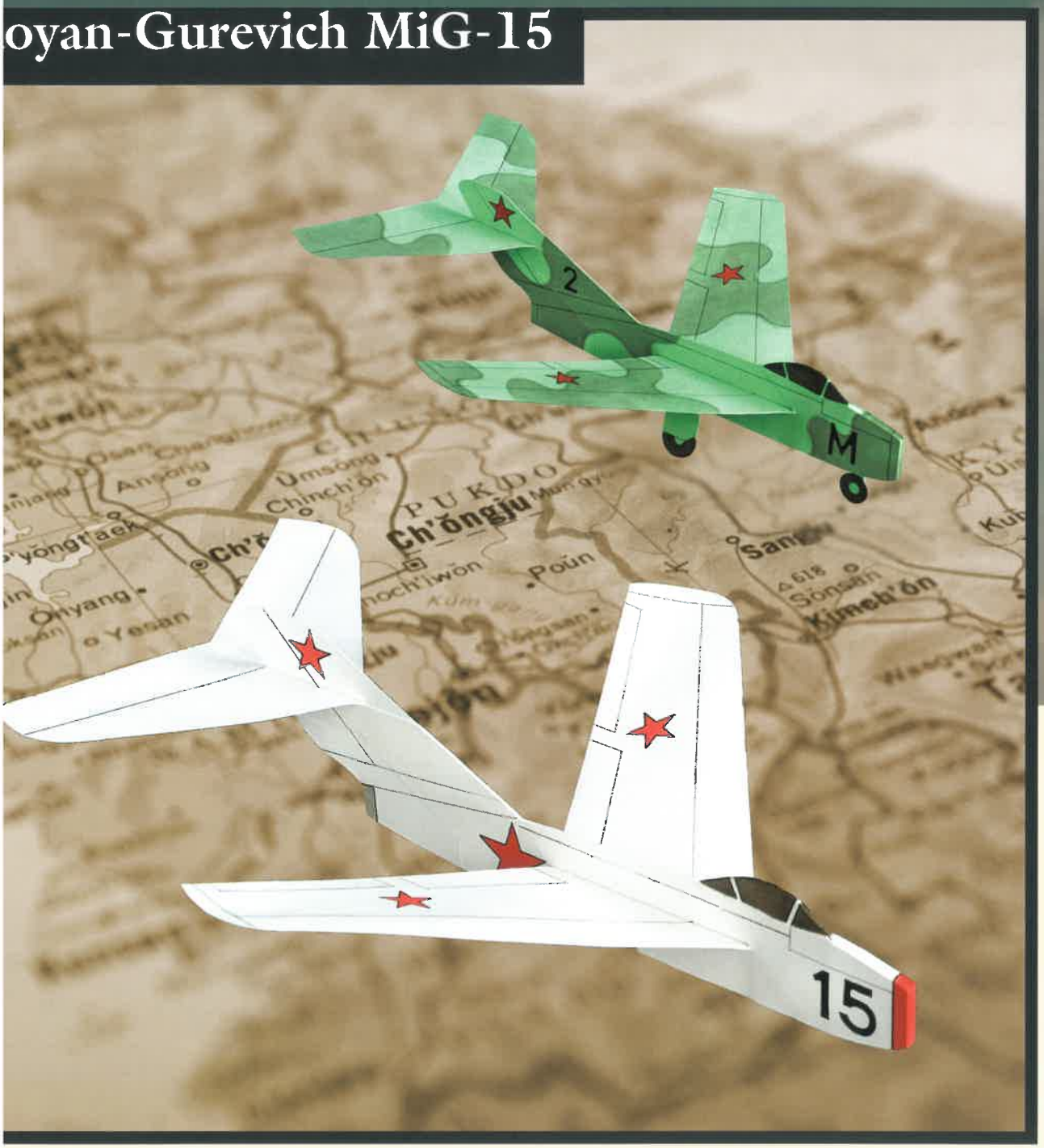
STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

Retracting undercarriage (if used, attach to wings at position lines)

SEE P37 FOR ASSEMBLY

Note: Some Yak-18 variants were built with a tricycle undercarriage. The model can be built either as a tail dragger or tricycle with nosewheel.

oyan-Gurevich MiG-15



[T p 51]

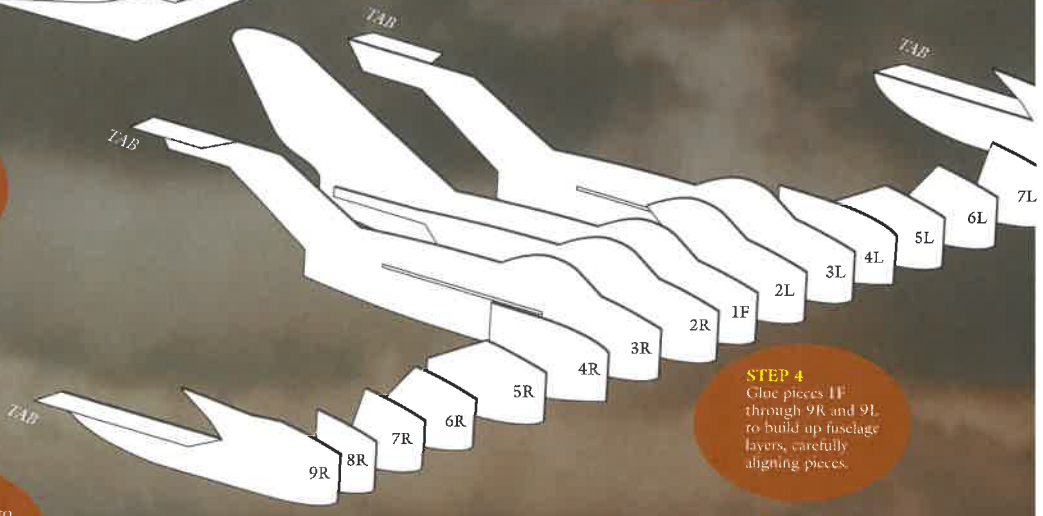
Year: 1949
Country of origin: Russia
Manufacturer: Mikoyan-Gurevich
Type: Single-seat fighter/fighter-bomber
Engine: one 5,952 lb thrust Klimov afterburning turbojet
Wing span: 33 ft (9.9 m)
Length: 35 ft 7 in (10.7 m)
Height: 12 ft 1 in (3.6 m)
Maximum speed: 668 mph (1,070 km/h)
Service ceiling: 50,900 ft (15,270 m)
Range: 1,156 miles (1,849 km)
Armament: one 37 mm and two 23 mm cannon in the nose, up to 1,100 lb of mixed underwing bombs

ASSEMBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.

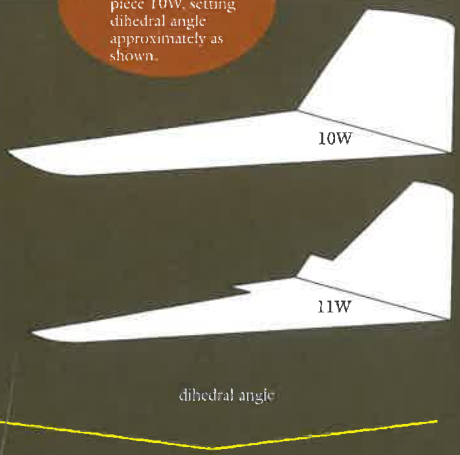
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.

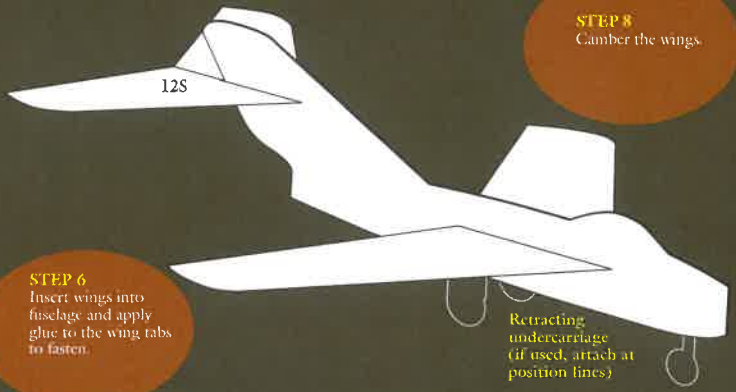


STEP 4
Glue pieces 1F through 9R and 9L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 11W to the bottom of wing piece 10W, setting dihedral angle approximately as shown.



STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 12S to the fuselage.



STEP 8
Camber the wings.

STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

Retracting undercarriage (if used, attach at position lines)

SEE P37 FOR ASSEMBLY

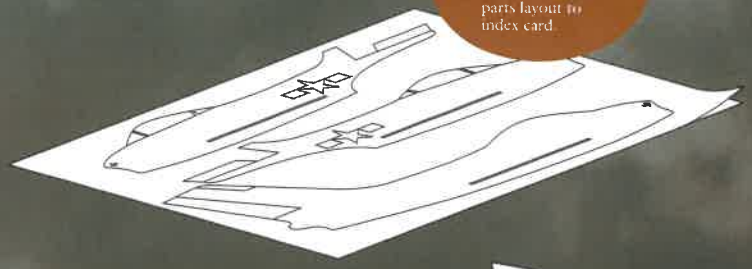
th American F-86 Sabre

[T p 51]

Year: 1949
Country of origin: United States of America
Manufacturer: North American
Type: Single-seat fighter/fighter-bomber
Engine: one General Electric J-47 7,500 lb thrust afterburning turbojet
Wing span: 39 ft (11.7 m)
Length: 37 ft 6 in (11.3 m)
Height: 14 ft 3 in (4.2 m)
Maximum speed: 678 mph (1,084 km/h)
Service ceiling: 50,000 ft (15,000 m)
Range: 1200 miles (1,900 km)
Armament: six 50 calibre machine-guns, 2 missiles, various external bombs

ASSEMBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.

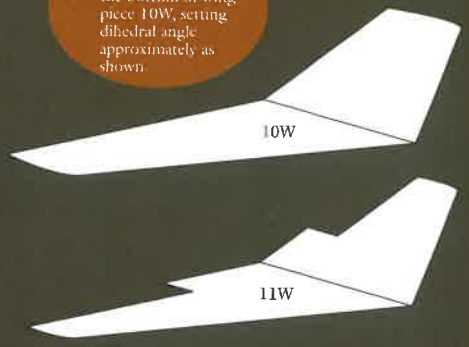


STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.

STEP 4
Glue pieces 1F through 9R and 9L to build up fuselage layers, carefully aligning pieces.

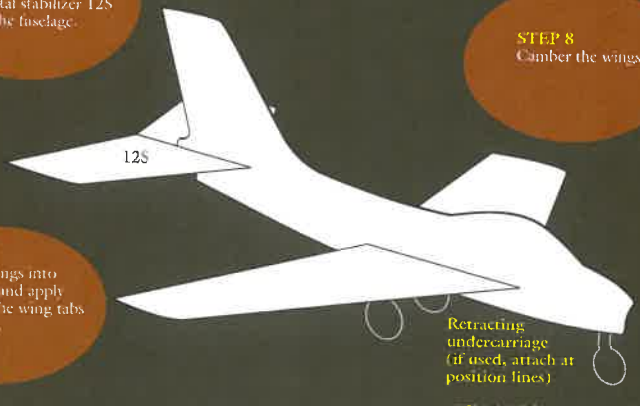
STEP 5
Glue piece 11W to the bottom of wing piece 10W, setting dihedral angle approximately as shown.



dihedral angle

STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 12S to the fuselage.

STEP 8
Camber the wings.



STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

Retracting undercarriage (if used, attach at position lines)

SEE P37 FOR ASSEMBLY

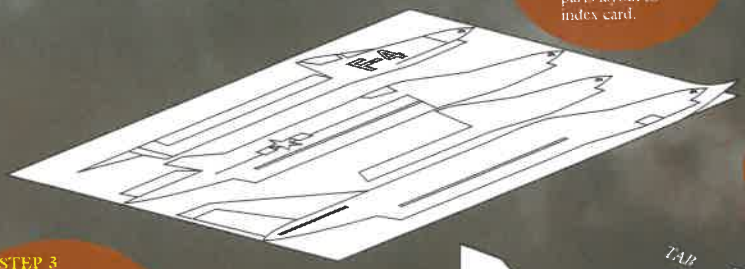
Donnell-Douglas F-4 Phantom

[T p 53]

Year: 1960
Country of origin: United States of America
Manufacturer: McDonnell-Douglas
Type: Single-seat fighter/fighter-bomber
Engine: two General Electric J79 17,900 lb thrust afterburning turbojets
Wing span: 38 ft 5 in (11.5 m)
Length: 63 ft (18.9 m)
Height: 16 ft 6 in (4.9 m)
Maximum Speed: 1,485 mph (2,376 km/h)
Service Ceiling: 62,000 ft. (18,600 m)
Range: 1,100 miles (1,760 km)
Armament: up to 3,020 lbs of cannon, bombs, or missiles under fuselage and up to 12,500 lbs under the wings

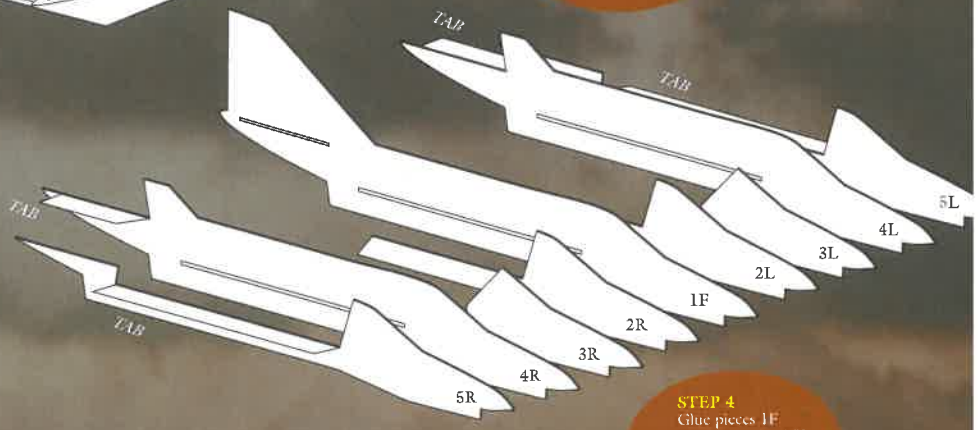
ASSEMBLY

STEP 1
Photocopy parts pages and tack-glue photocopied parts layout to index card.



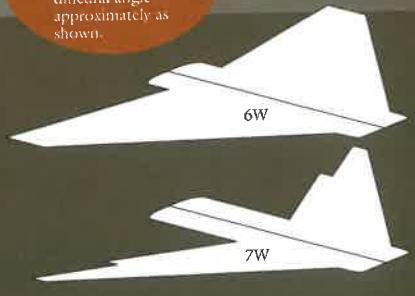
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.

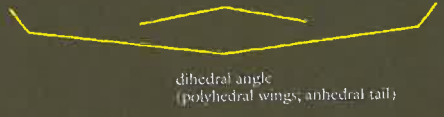


STEP 4
Glue pieces 1F through 5R and 5L to build up fuselage layers, carefully aligning pieces.

STEP 5
Glue piece 7W to the bottom of wing piece 6W, setting dihedral angle approximately as shown.



STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 8S to the fuselage.



dihedral angle
(polyhedral wings; anhedral tail)

STEP 8
Camber the wings.

Retracting undercarriage (if used, attach at position lines)

SEE P37 FOR ASSEMBLY

STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

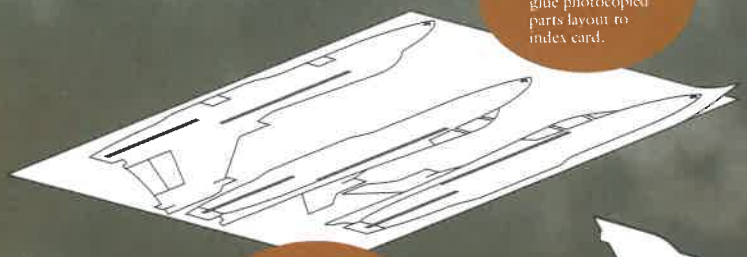
ıavia Tornado

:T p 54]

Year: 1980
Country of origin: Britain, Germany, Italy
Manufacturer: Panavia
Type: two-seat fighter/fighter-bomber
Engine: two Turbo-Union 14,480 lb thrust after-burning turbojets
Wing span: 45 ft 7 in (13.7 m) unswept, 28 ft 2 in (8.4 m) swept
Length: 54 ft 9 in (16.5 m)
Height: 19 ft 6 in (5.9 m)
Maximum speed: 1,452 mph (2,323 km/h)
Service ceiling: 50,000 ft (15,000 m)
Range: 2,432 miles (3,890 km) with 4 drop tanks
Armament: two 27 mm internal cannon, up to 20,000 lb (9000 kg) external missiles and bombs

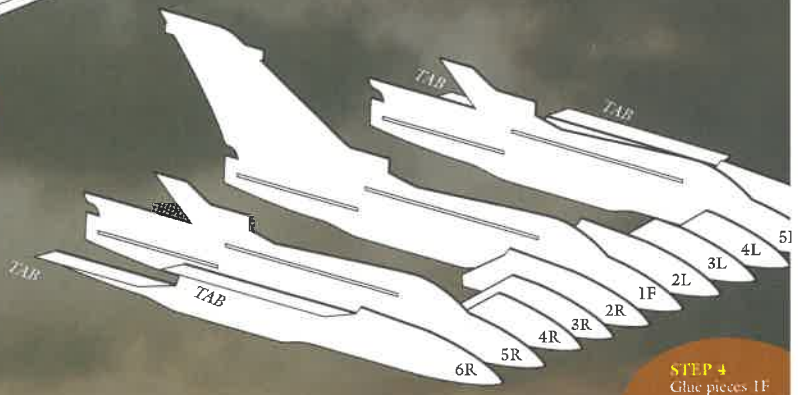
ASSEMBLY

STEP 1
Photocopy parts pages and tack/glue photocopied parts layout to index card.



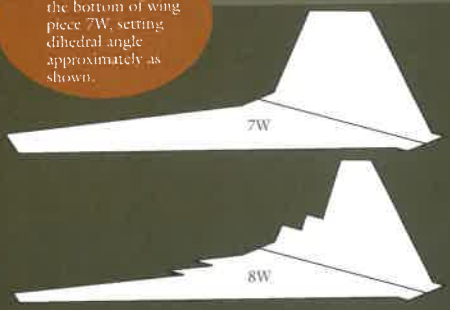
STEP 2
Score the fold lines for tabs. Cut all openings that lie within the parts.

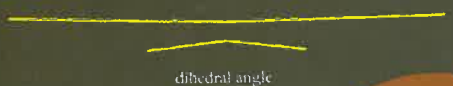
STEP 3
Cut each piece from the index card stock. Remove photocopied paper. Write part number on each piece.



STEP 4
Glue pieces 1F through 6R and 6
to build up fuselag
layers, carefully
aligning pieces.

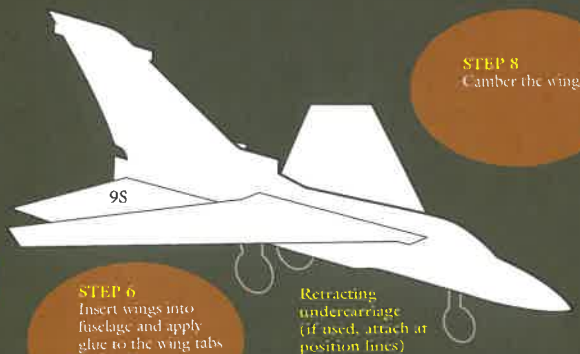
STEP 5
Glue piece 8W to the bottom of wing piece 7W, setting dihedral angle approximately as shown.





dihedral angle
(anhedral tail)

STEP 7
Applying glue to the tail tabs, fasten horizontal stabilizer 9S to the fuselage.

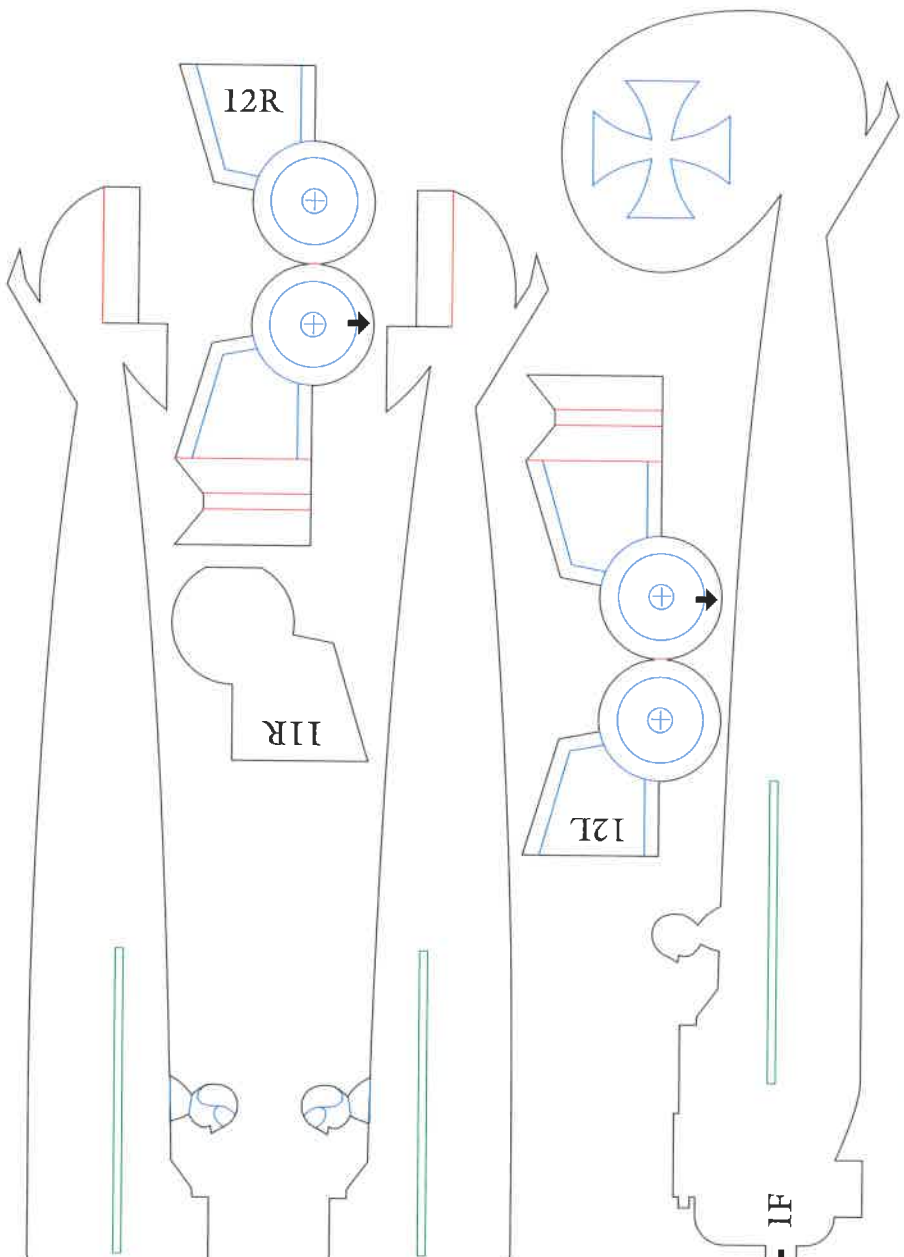


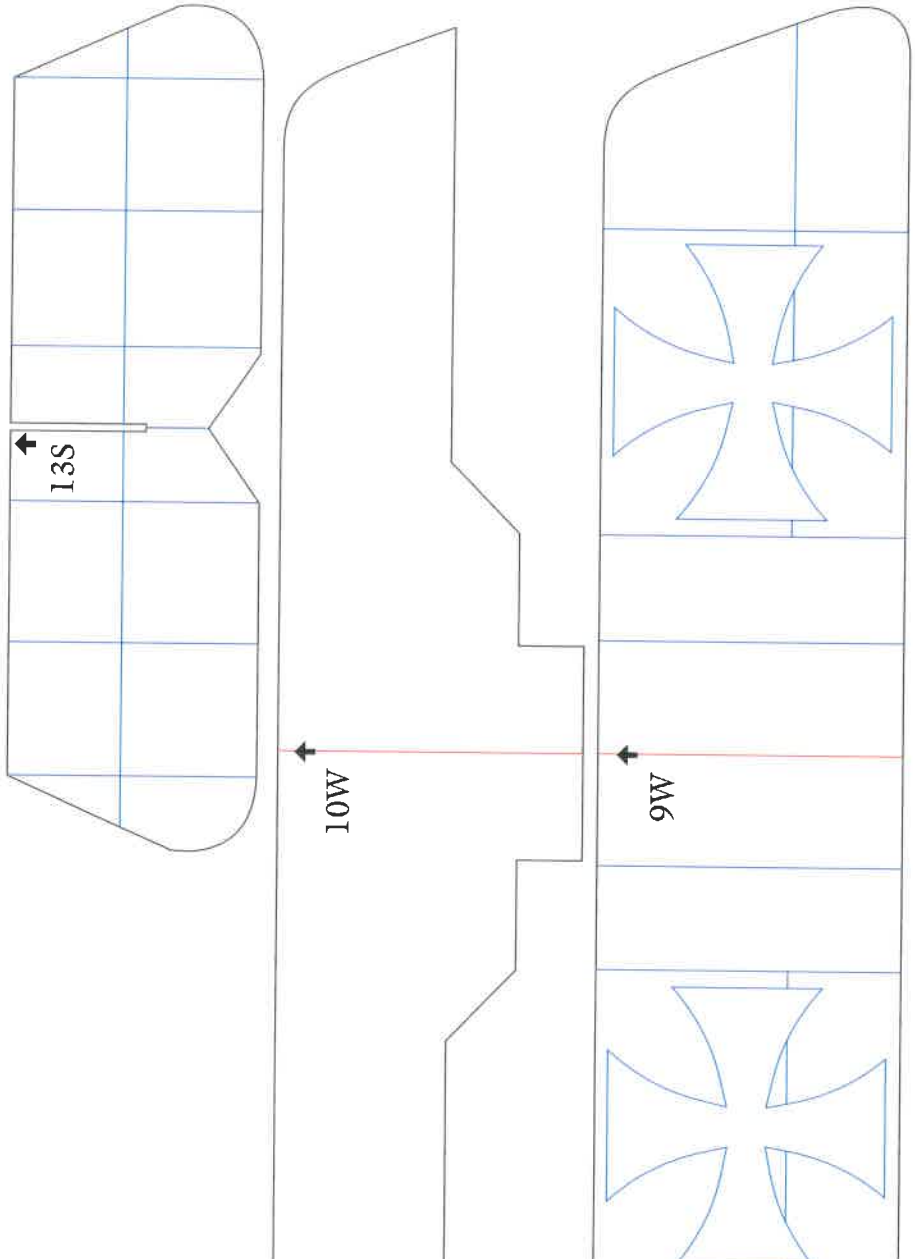
STEP 8
Camber the wings.

STEP 6
Insert wings into fuselage and apply glue to the wing tabs to fasten.

Retracting undercarriage (if used, attach at position lines)

SEE P37 FOR ASSEMBLY


12R
11R
12L
1F


13S
10W
9W

2L
8L
8R
3L
7L
7R
6L
L WHEEL PLACEMENT
R WHEEL PLACEMENT
5L

2R
16R
16L
1F

9W

STRUT

STRUT PLACEMENT

STRUT PLACEMENT

10W

STRUT PLACEMENT

11W

STRUT

STRUT PLACEMENT

12W

8R

15L

17S

15R

3R

14TR

14TL

4R

5L

5R

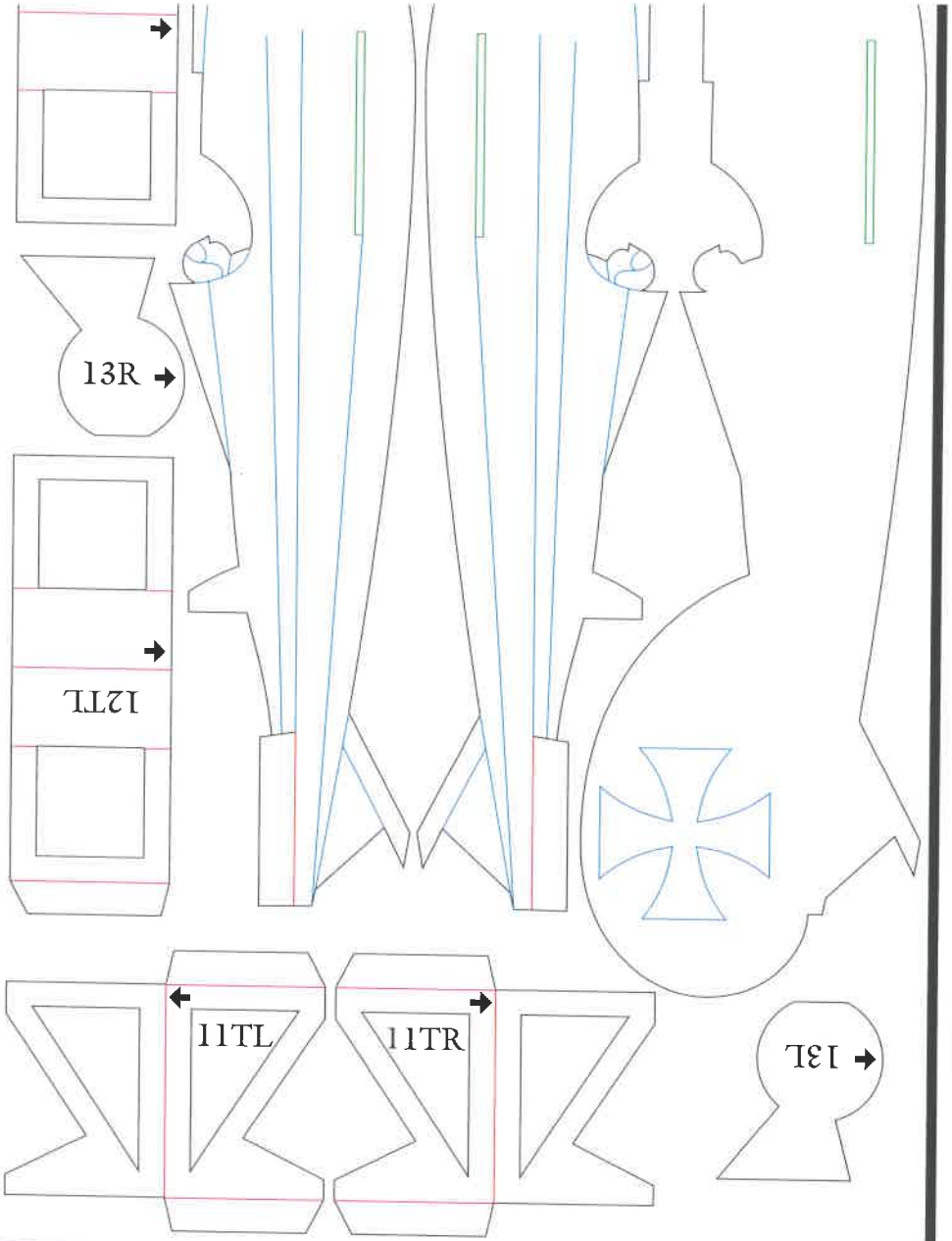
6L

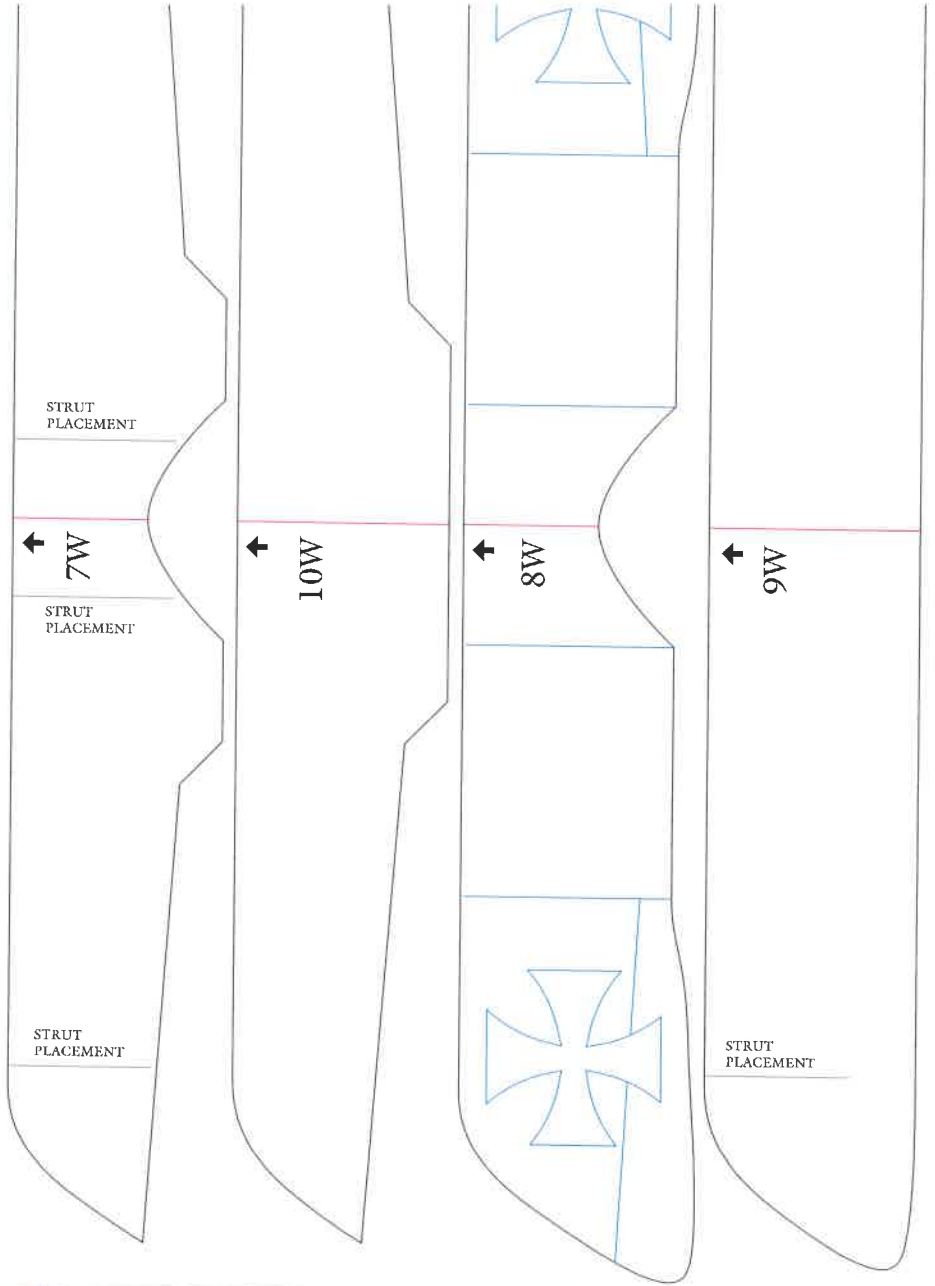
6R

7R

WHEEL LACEMENT

R WHEEL PLACEMENT


13R
12TL
11TL
11TR
13L

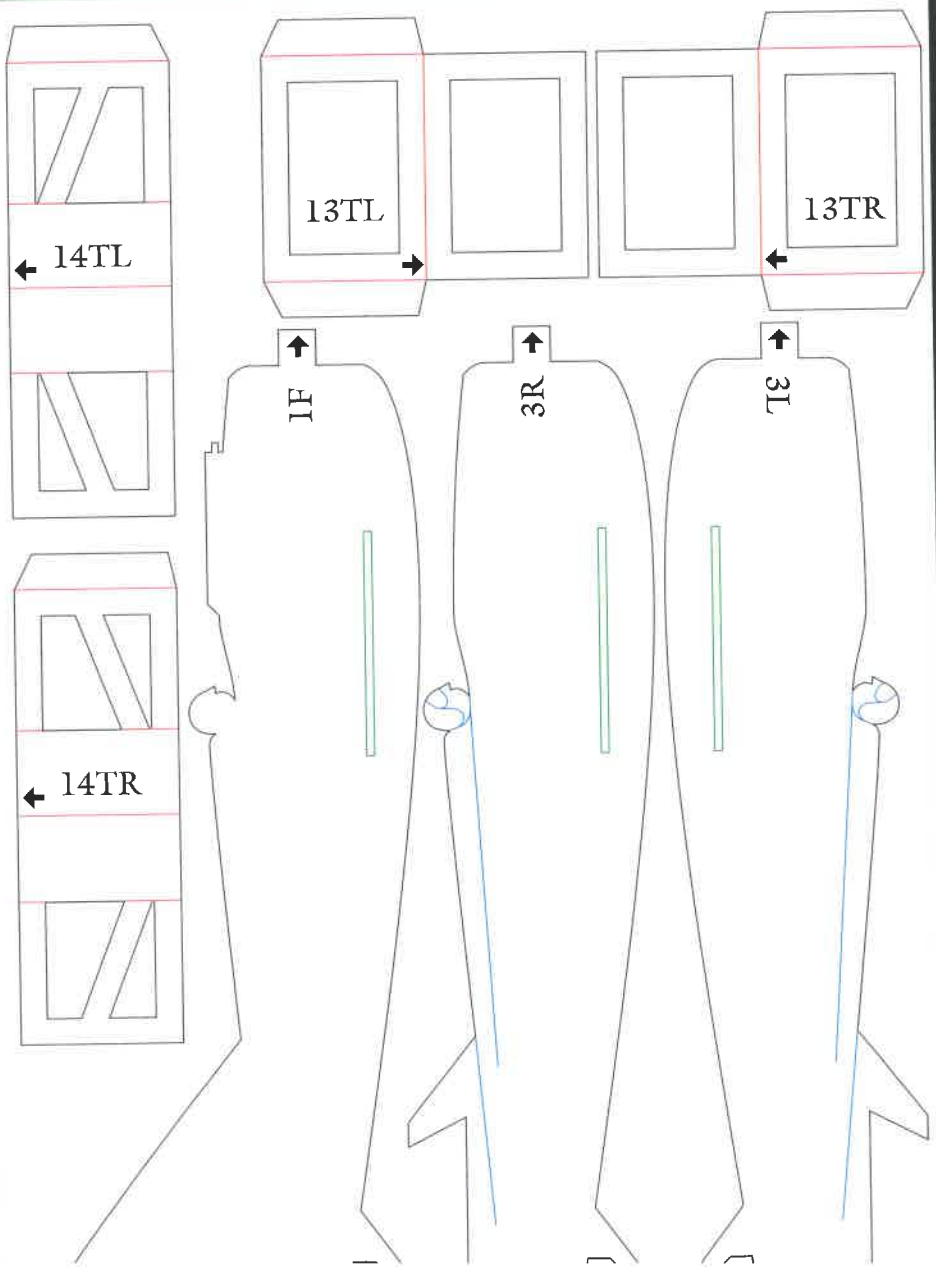

STRUT PLACEMENT
7W
STRUT PLACEMENT
STRUT PLACEMENT
10W
8W
9W
STRUT PLACEMENT

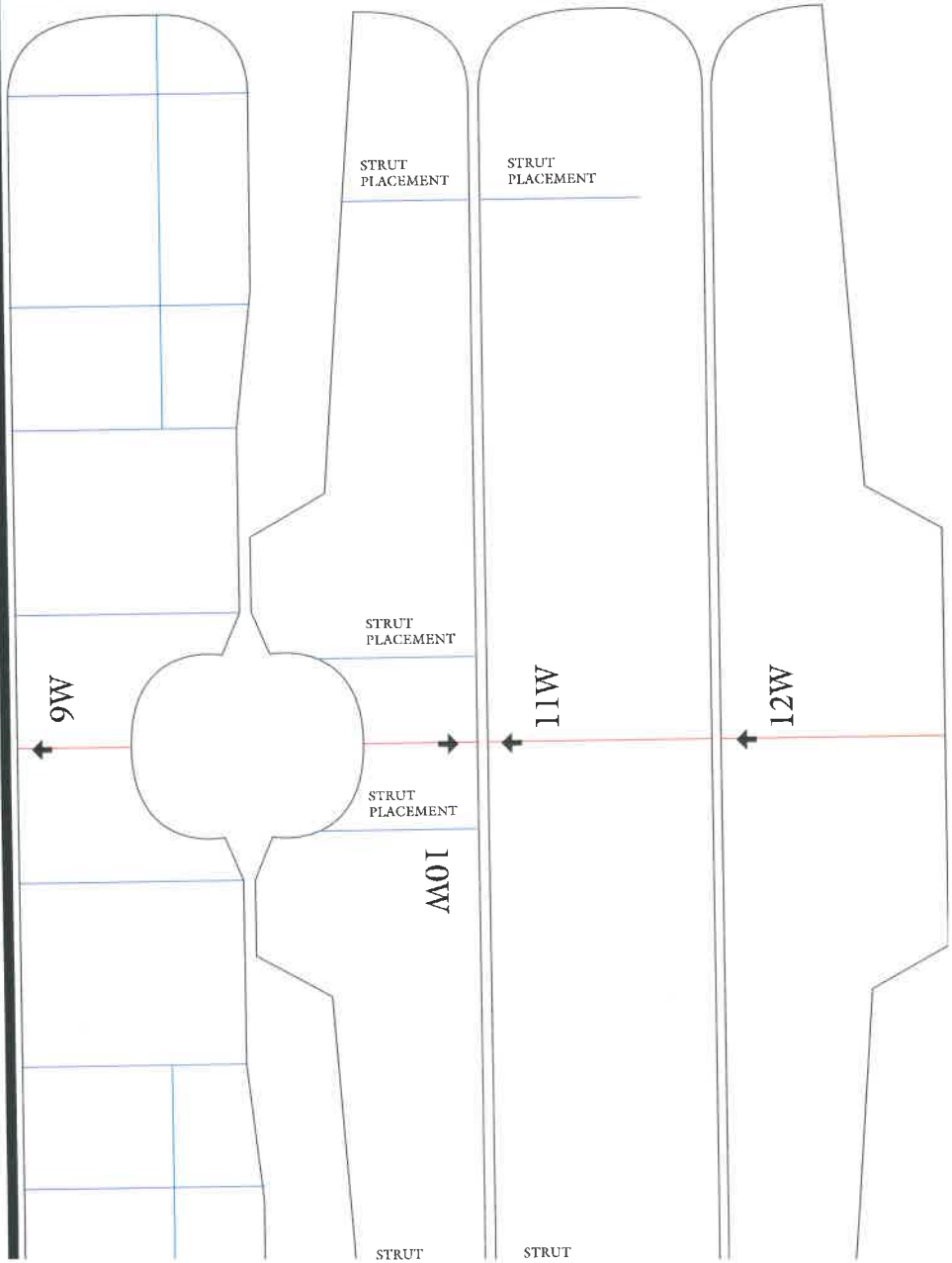
15S
3R
6R
14R
4R
6L
14L
5R
L WHEEL PLACEMENT
R WHEEL PLACEMENT

17S
13TL
1F
2L
13TR
2R

9W
10W
STRUT PLACEMENT
STRUT PLACEMENT
STRUT PLACEMENT
11W
STRUT PLACEMENT
12W

7L
8L
13TR
8R
13TL
4L
3L
3R
16L
16R
5L
19R
6L
19L
L WHEEL PLACEMENT
R WHEEL PLACEMENT


14TL
13TL
13TR
1F
3R
3L
14TR

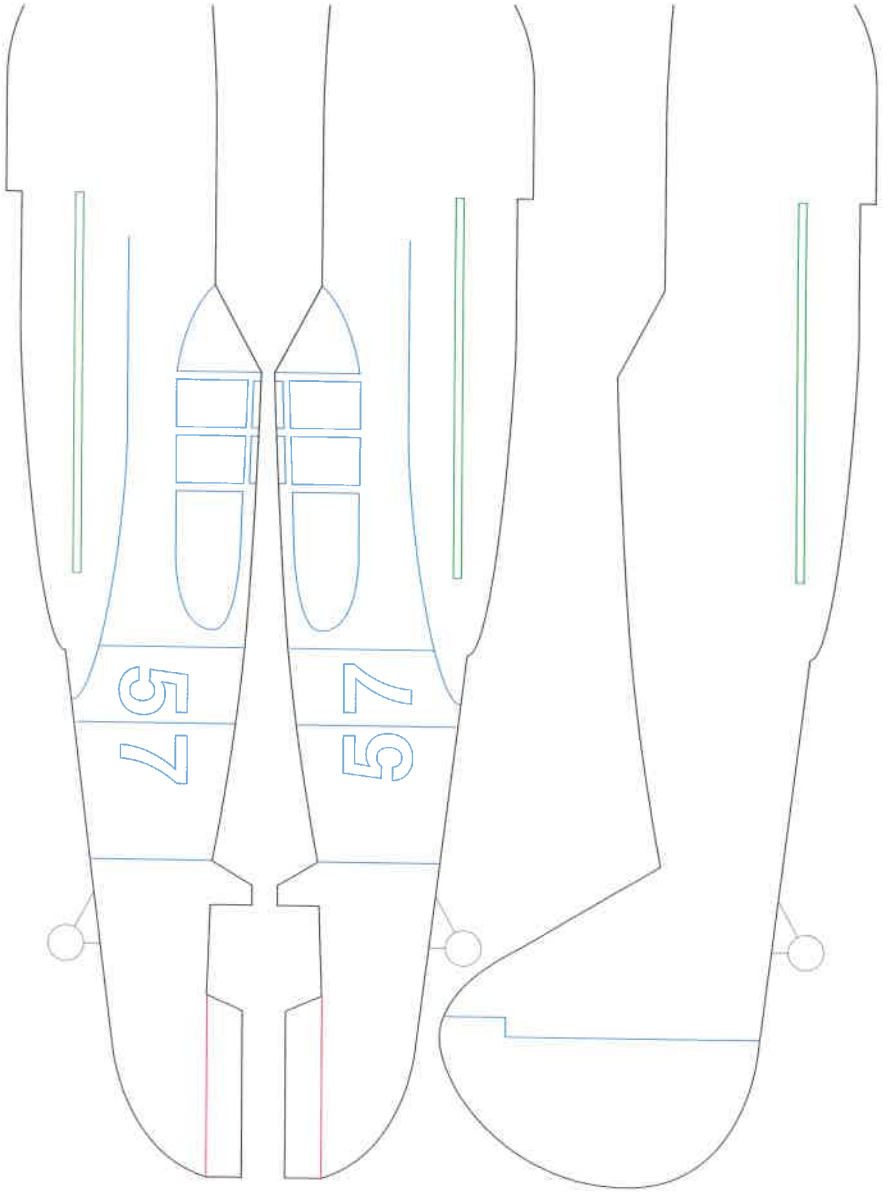

STRUT PLACEMENT
STRUT PLACEMENT
STRUT PLACEMENT
STRUT PLACEMENT
9W
10W
11W
12W
STRUT
STRUT

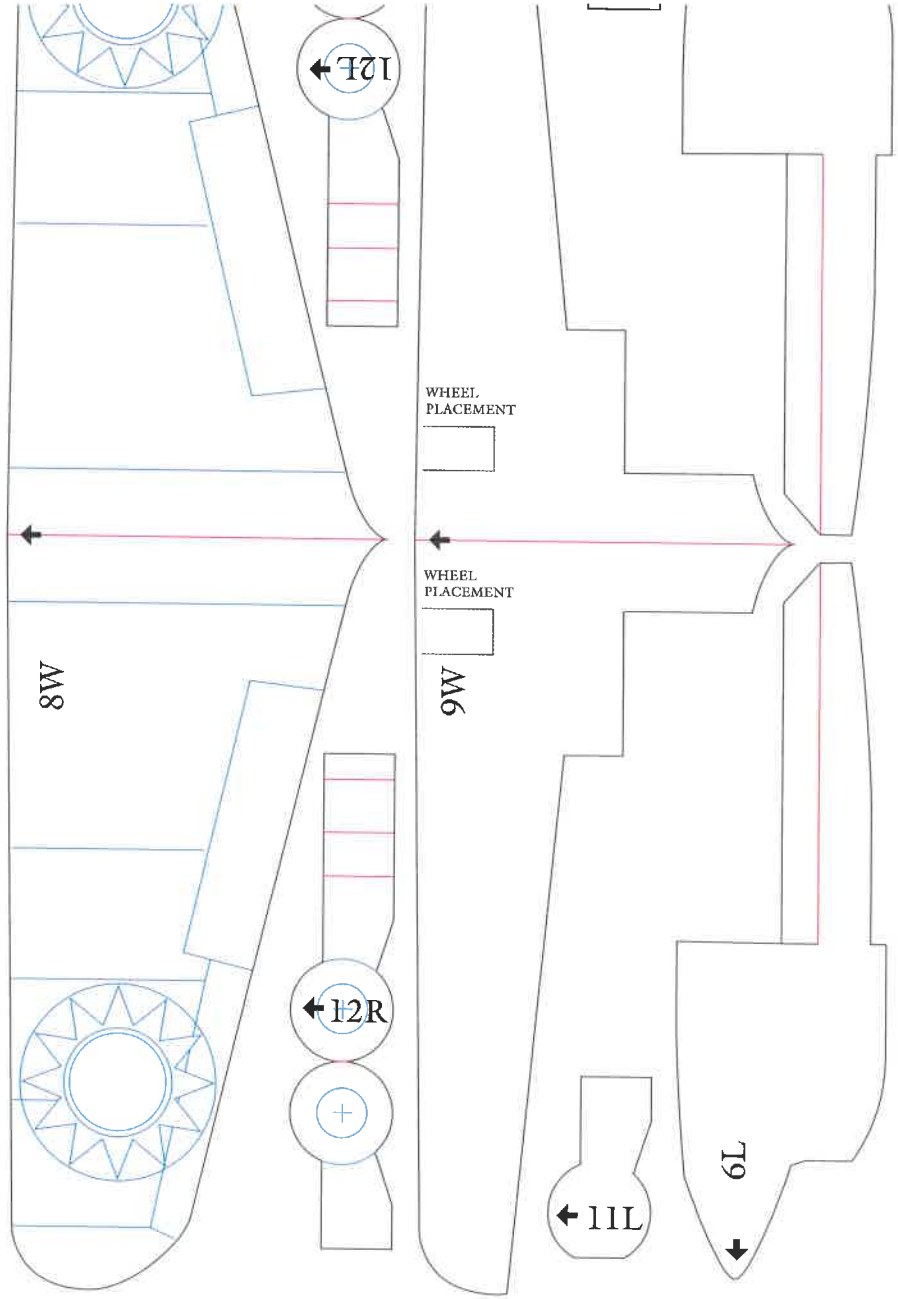
MODEL #5 Spad XIII parts 3/3

MODEL #6 Junkers D.I parts 1/3

M8
4L
M6

11L
3R
5L
5R
10R
6R
2L
2R
7R
L WHEEL PLACEMENT
R WHEEL PLACEMENT


25
57

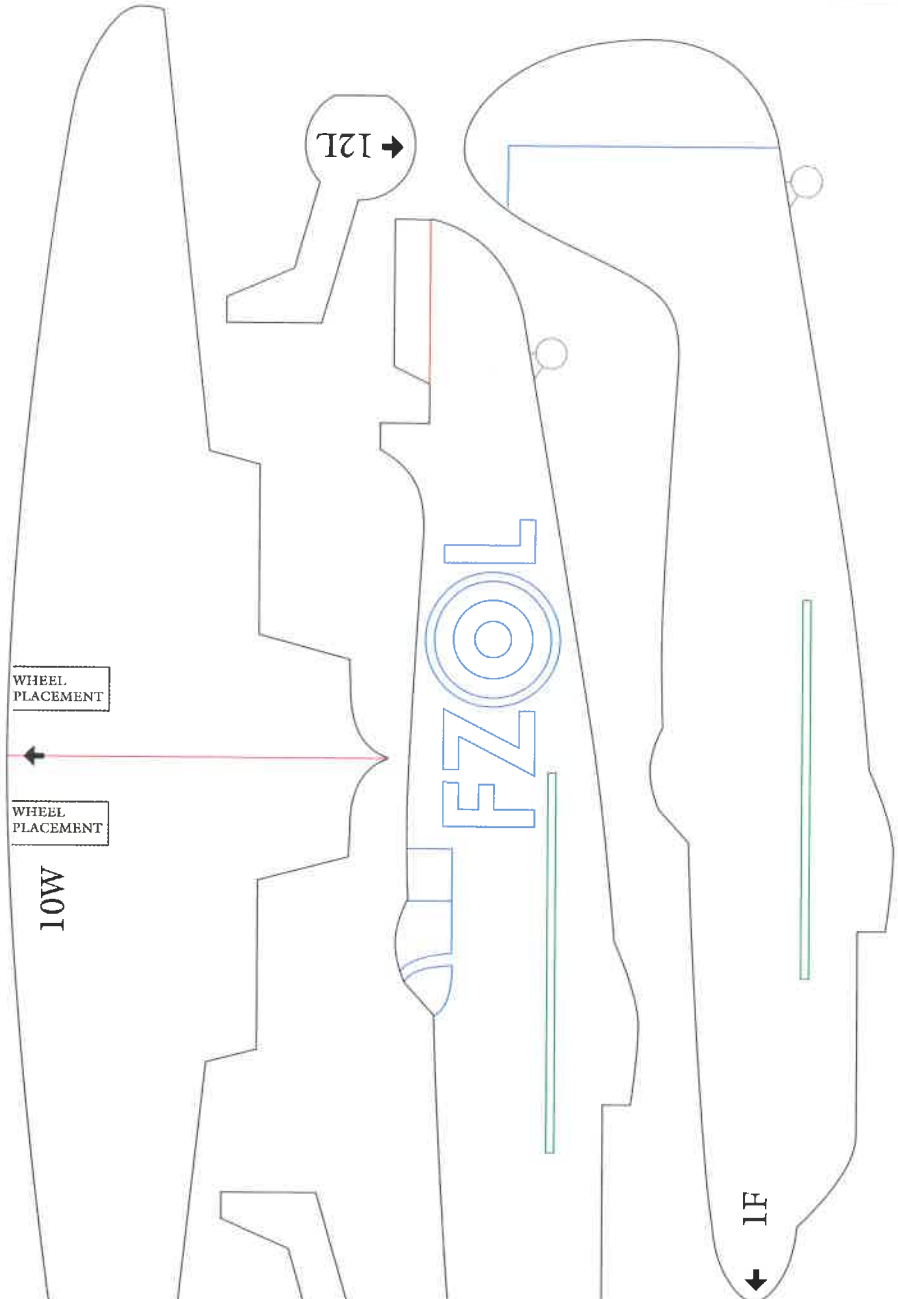

12L
WHEEL PLACEMENT
WHEEL PLACEMENT
8W
9W
12R
11L
9L

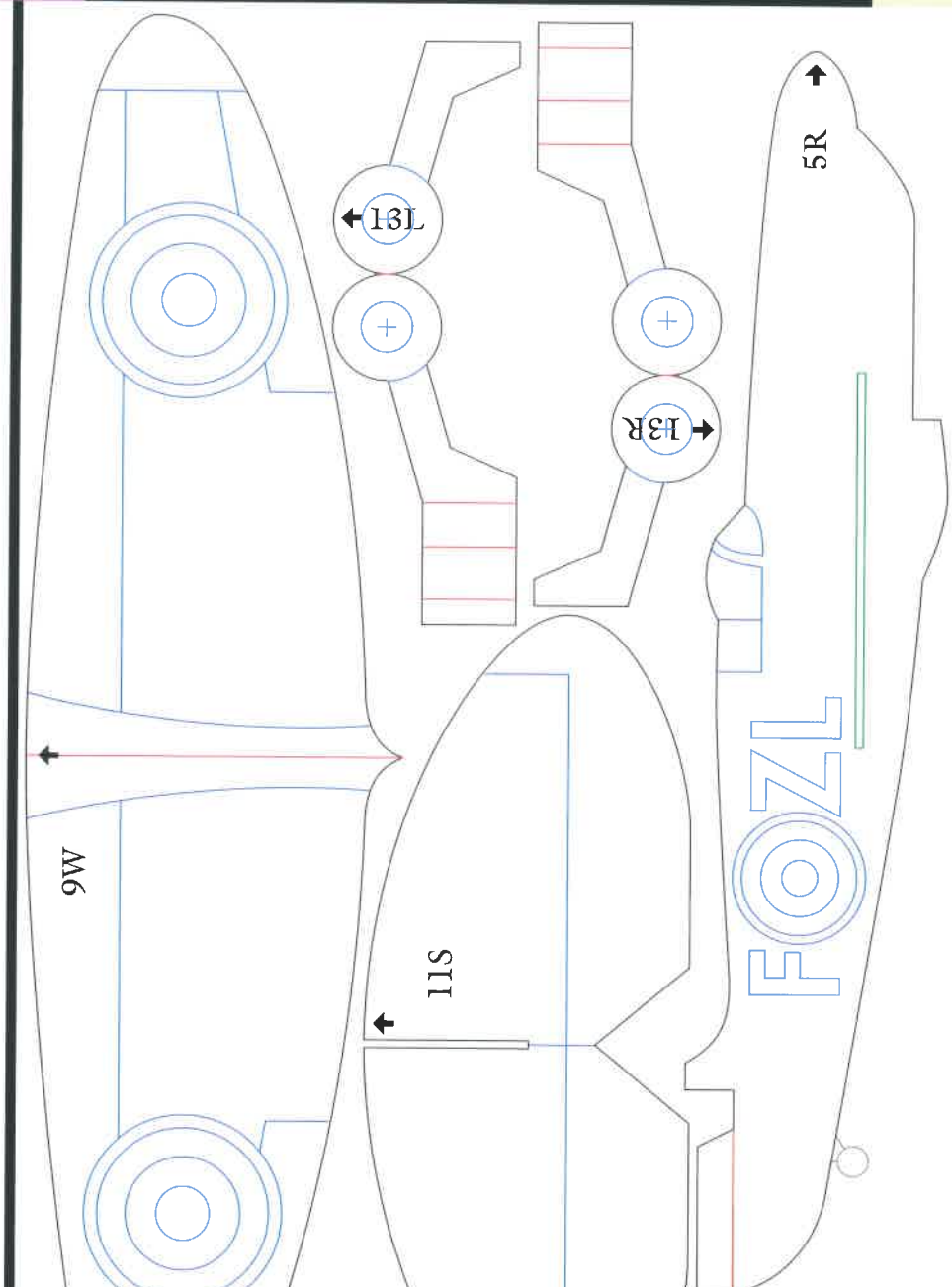
S01
2R
7L
7R
4R
3R

S11
M6

3R
3L
10W
WHEEL PLACEMENT
WHEEL PLACEMENT
13L
13R

5L
12L
12R
6L
6R
4L
8L
8R
2L
7L


12L
WHEEL PLACEMENT
WHEEL PLACEMENT
10W
1F


13L
13R
5R
9W
11S

4L
8L
8R
3L
6L
6R
2L
7L

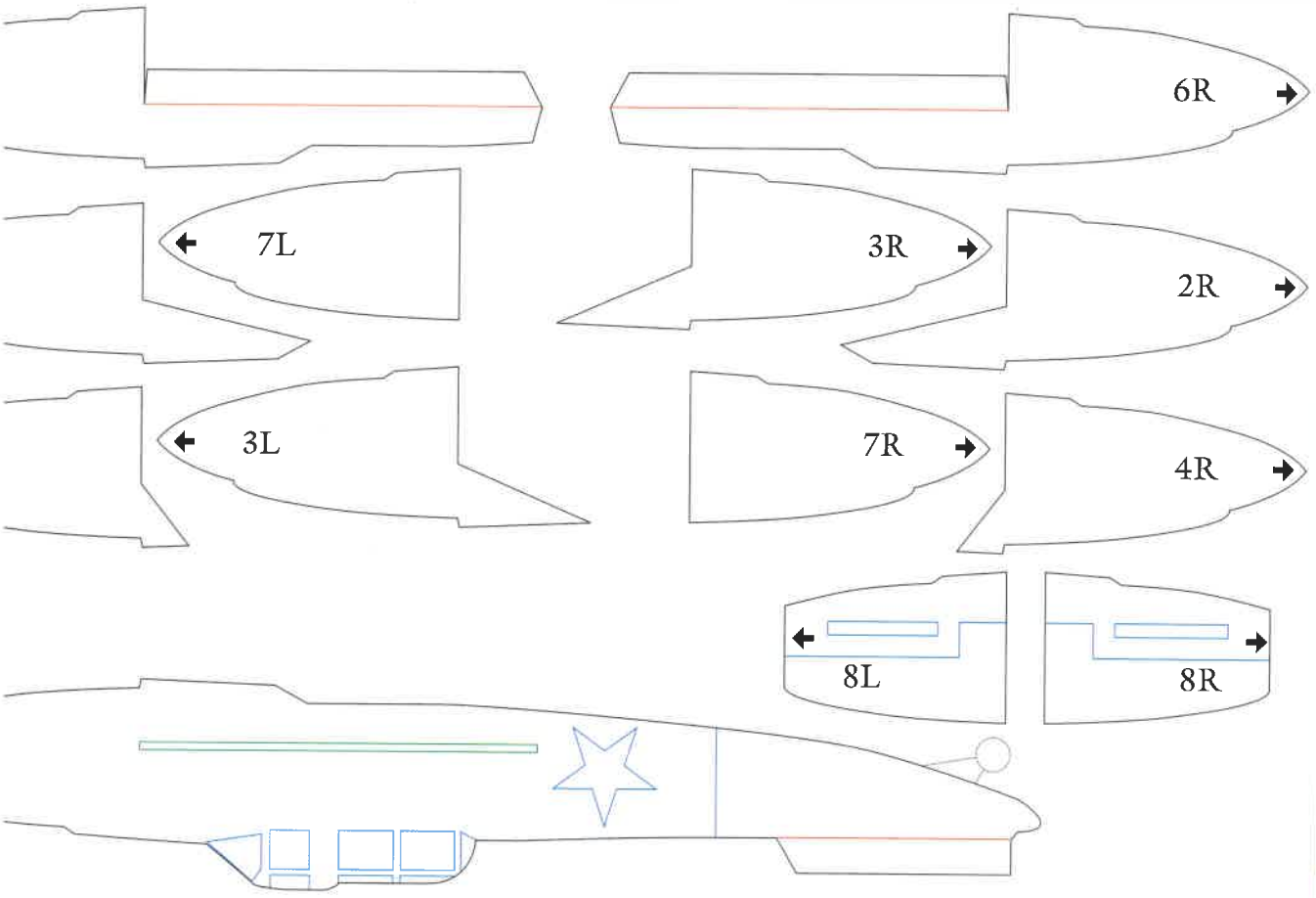
10W
7L
7R
12S
1F

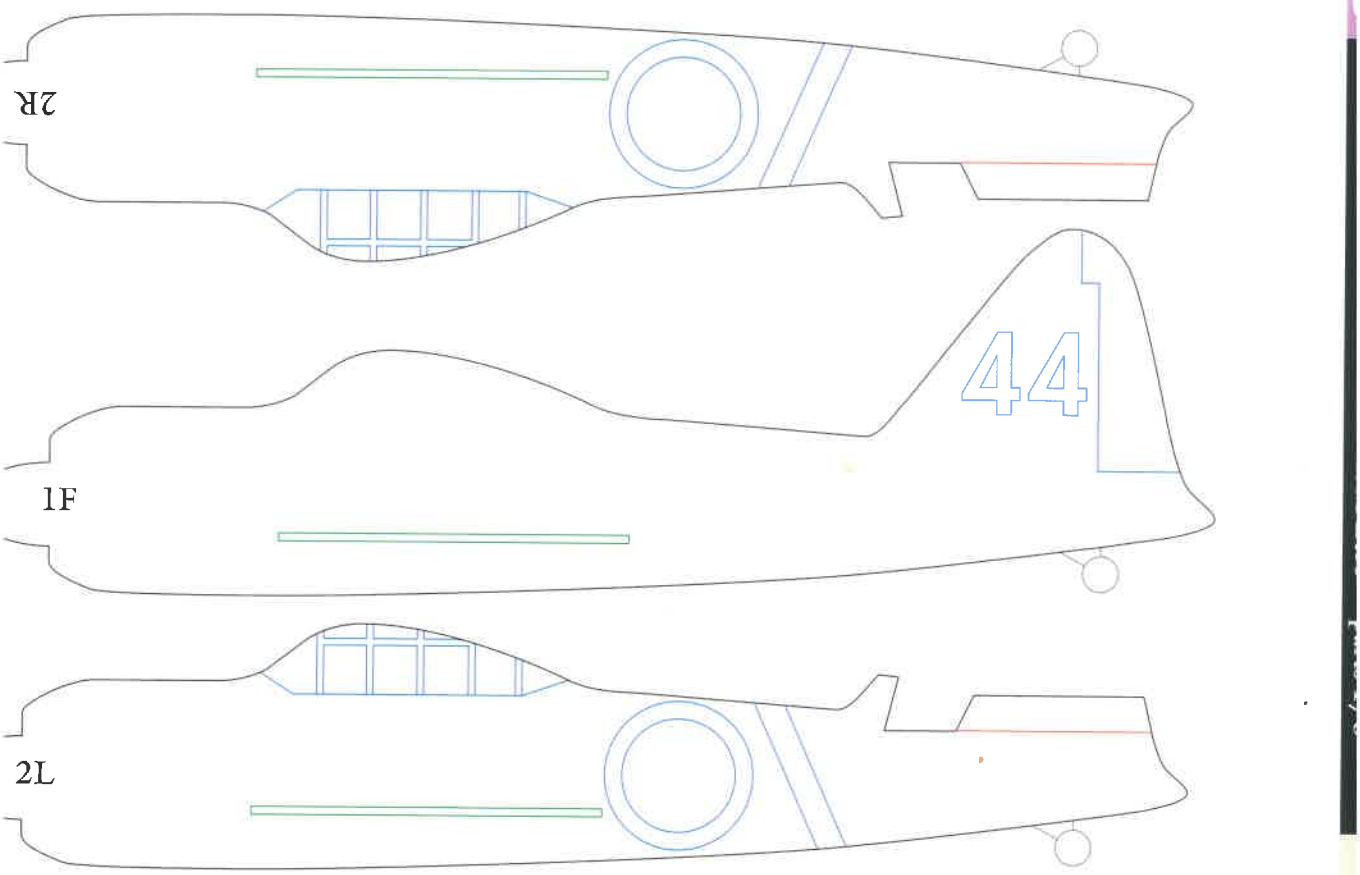
13L
9R
9L
11W
WHEEL PLACEMENT
WHEEL PLACEMENT
13R

14L
2R
6R
3R
6L
5R
14R
8R

11S
1F
5L

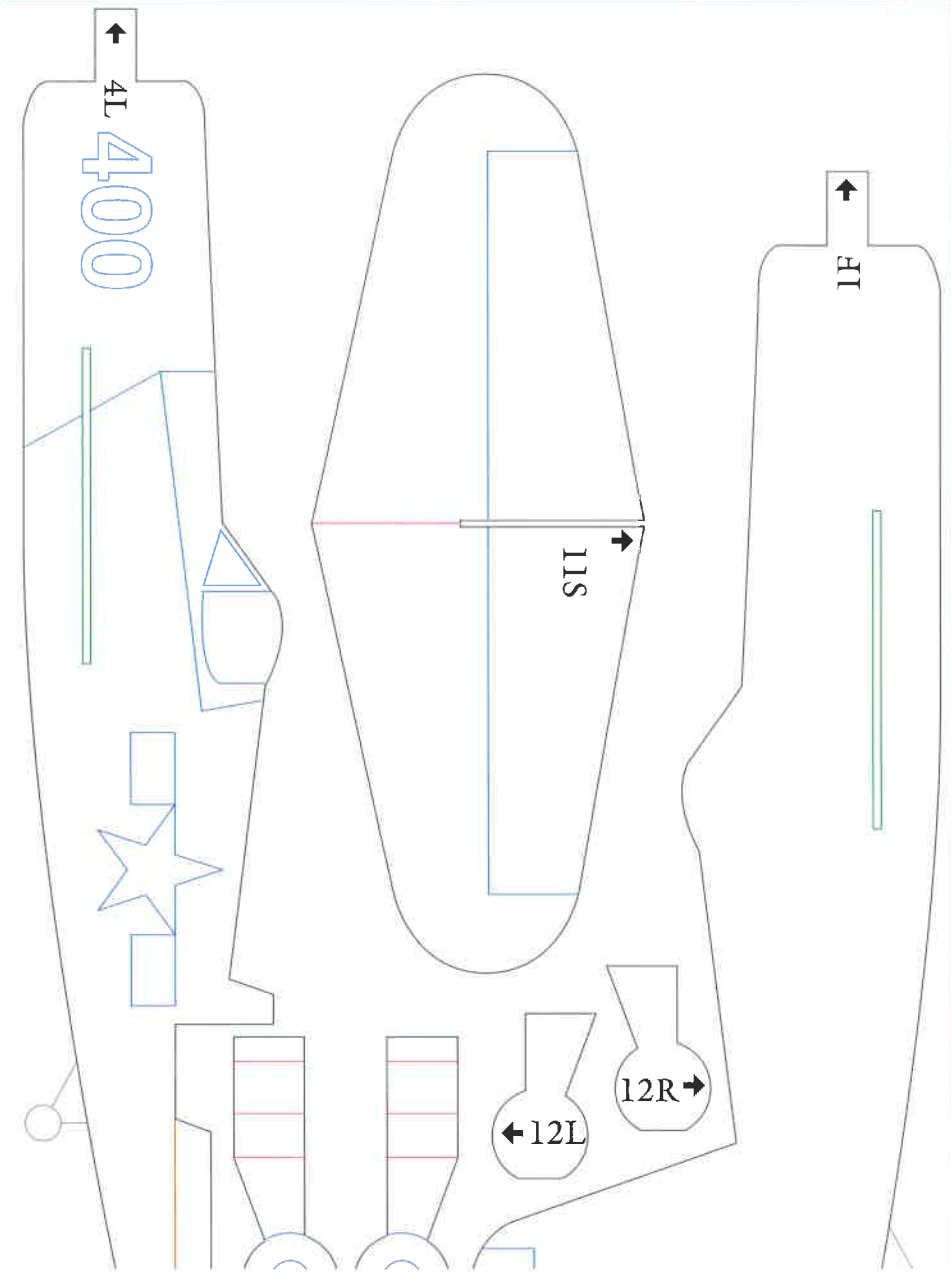
9W
12R
WHEEL PLACEMENT
WHEEL PLACEMENT
10W
13L

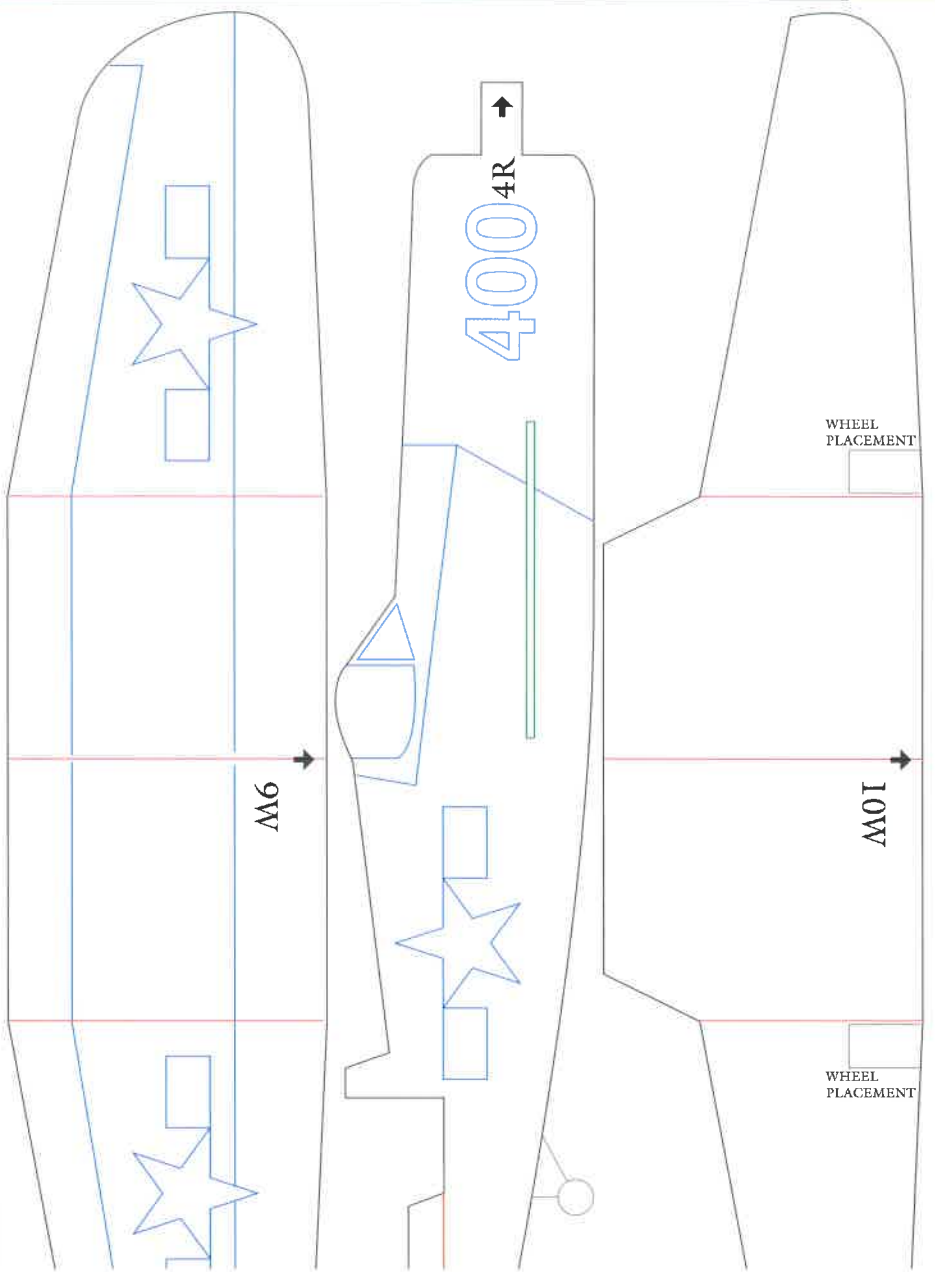

6R
7L
3R
2R
3L
7R
4R
8L
8R


2R
44
1F
2L

9W
10W
WHEEL PLACEMENT
WHEEL PLACEMENT
11S

5R
5L
7R
4R
4L
7L
6R
3R
3L
6L
13R
12L
8R
8L
12R


4L
400
11S
1F
12L
12R

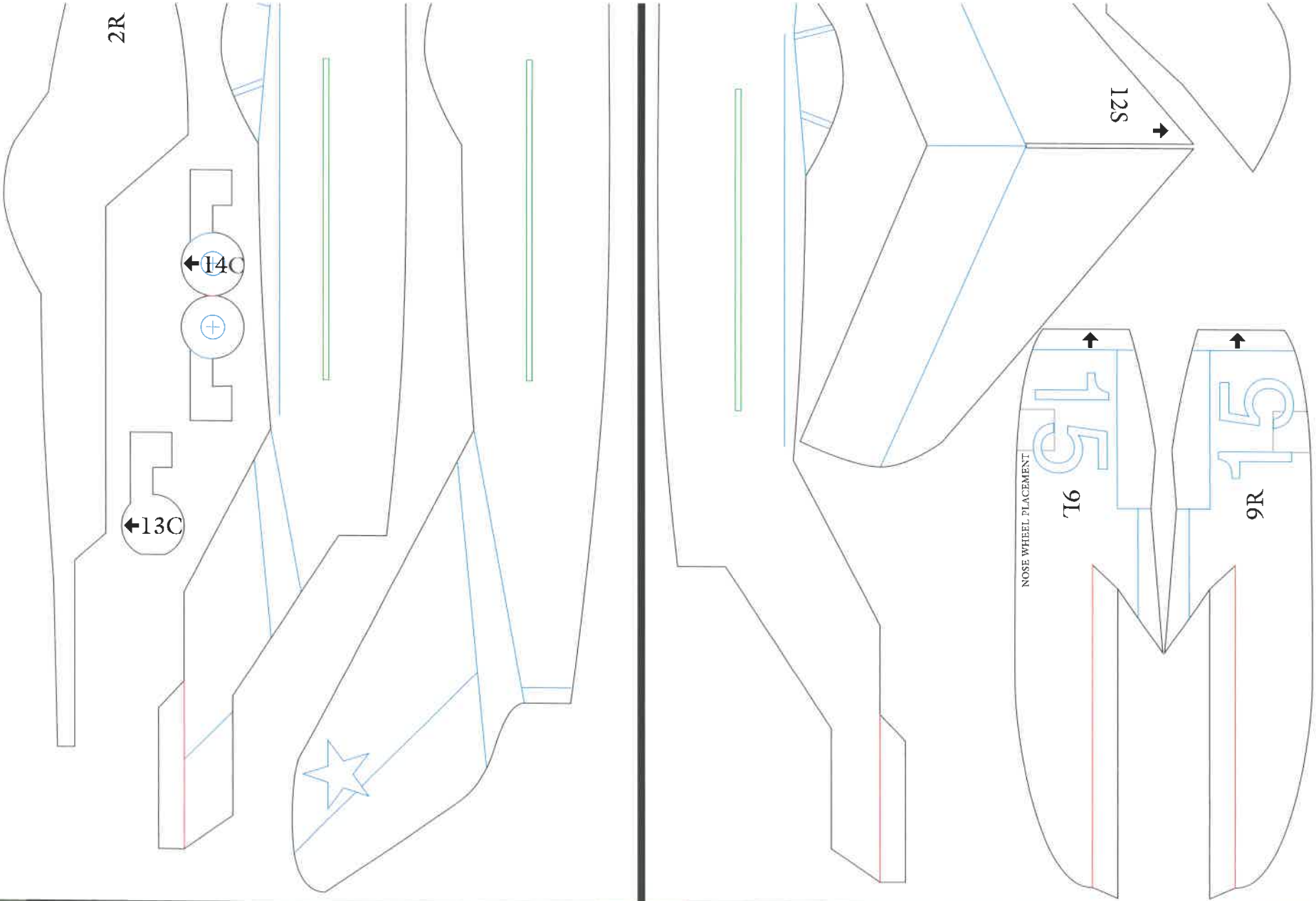

9W
4R
400
10W
WHEEL PLACEMENT
WHEEL PLACEMENT

5L
8L
8R
7L
7R
3L
2L
6L

18
12R
18
13L
13R

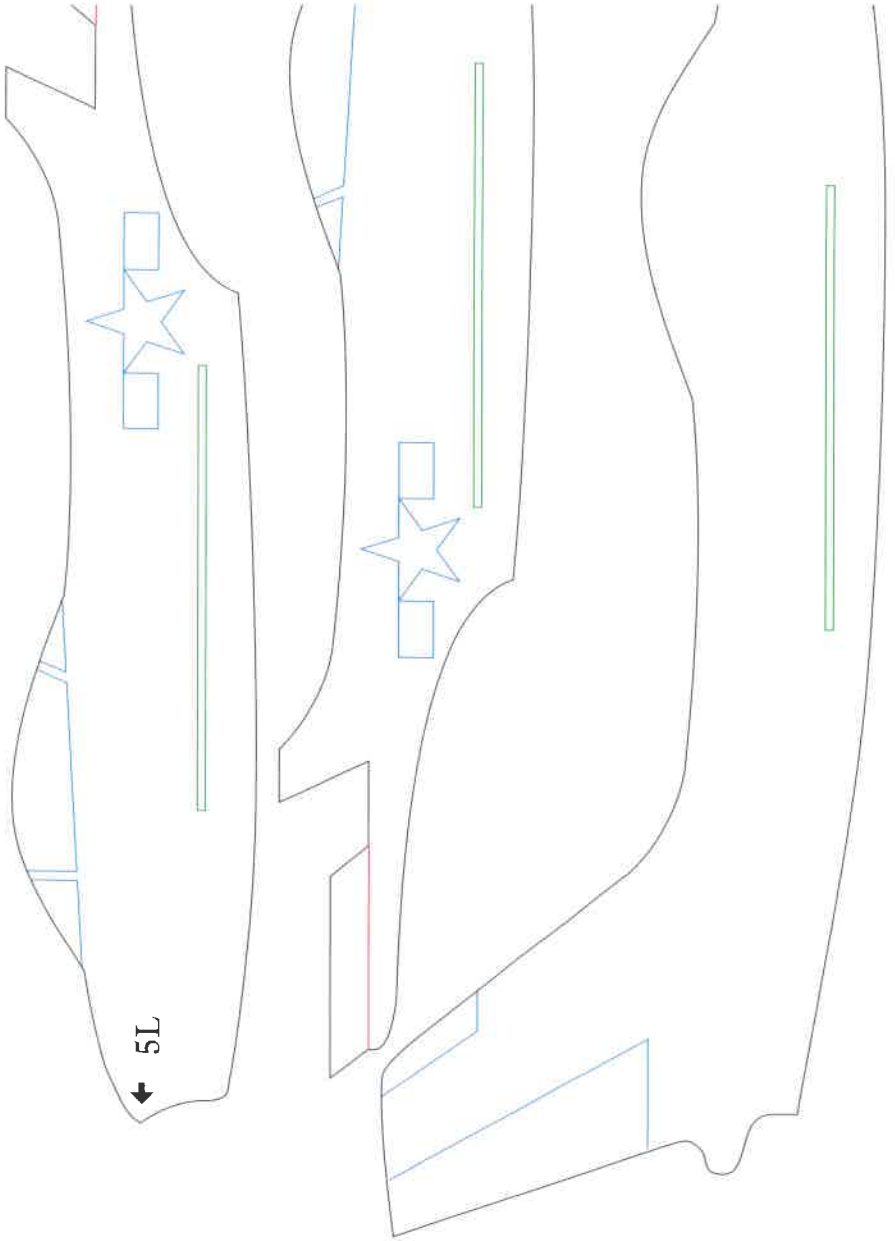
WHEEL PLACEMENT
WHEEL PLACEMENT
10W
OPTIONAL WHEEL PLACEMENT
OPTIONAL WHEEL PLACEMENT
7R
9W

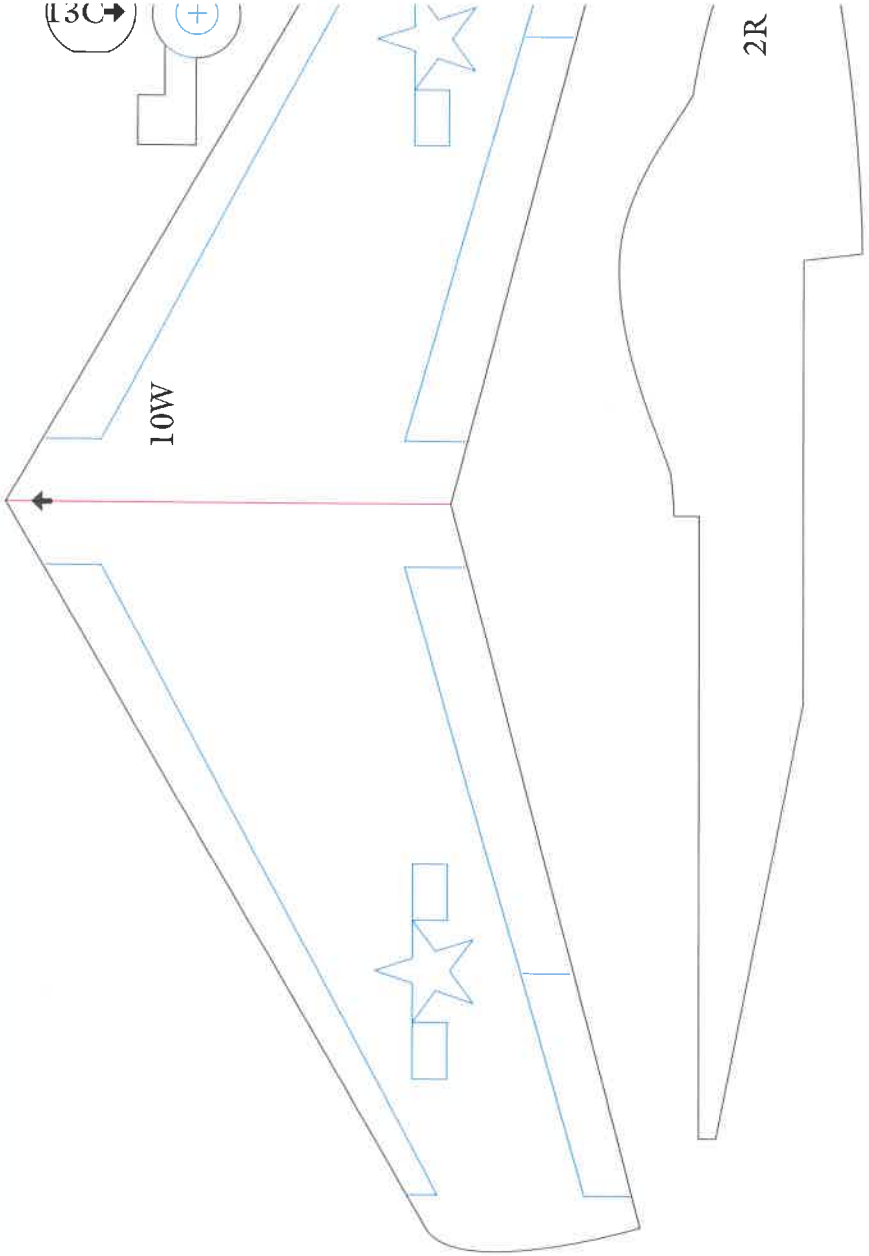
8R
11S
OPTIONAL NOSE WHEEL
13C
6L
6R
4R
5L
5R
2R


2R
14C
13C
12S
NOSE WHEEL PLACEMENT
9L
9R

14R
13L
4R
10W
5R
6R
7R
8R

14L
13R
4L
11W
WHEEL PLACEMENT
WHEEL PLACEMENT
5L
6L
7L
8L





MODEL #16 North American F-86 Sabre parts 1/4

MODEL #16 North American F-86 Sabre parts 2/4

14L
11W
14R
13L
WHEEL PLACEMENT
WHEEL PLACEMENT
12S
2L

NOSE WHEEL PLACEMENT
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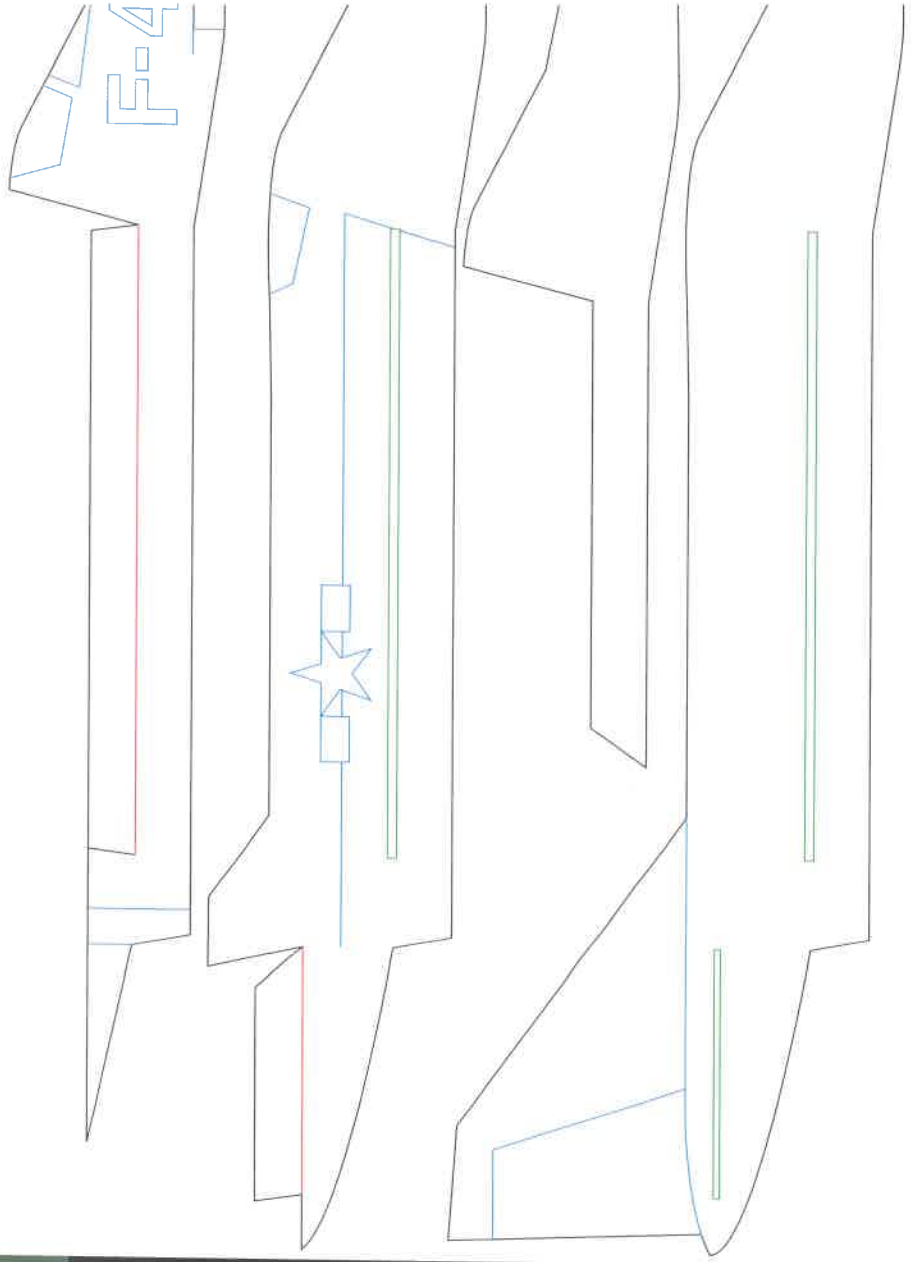
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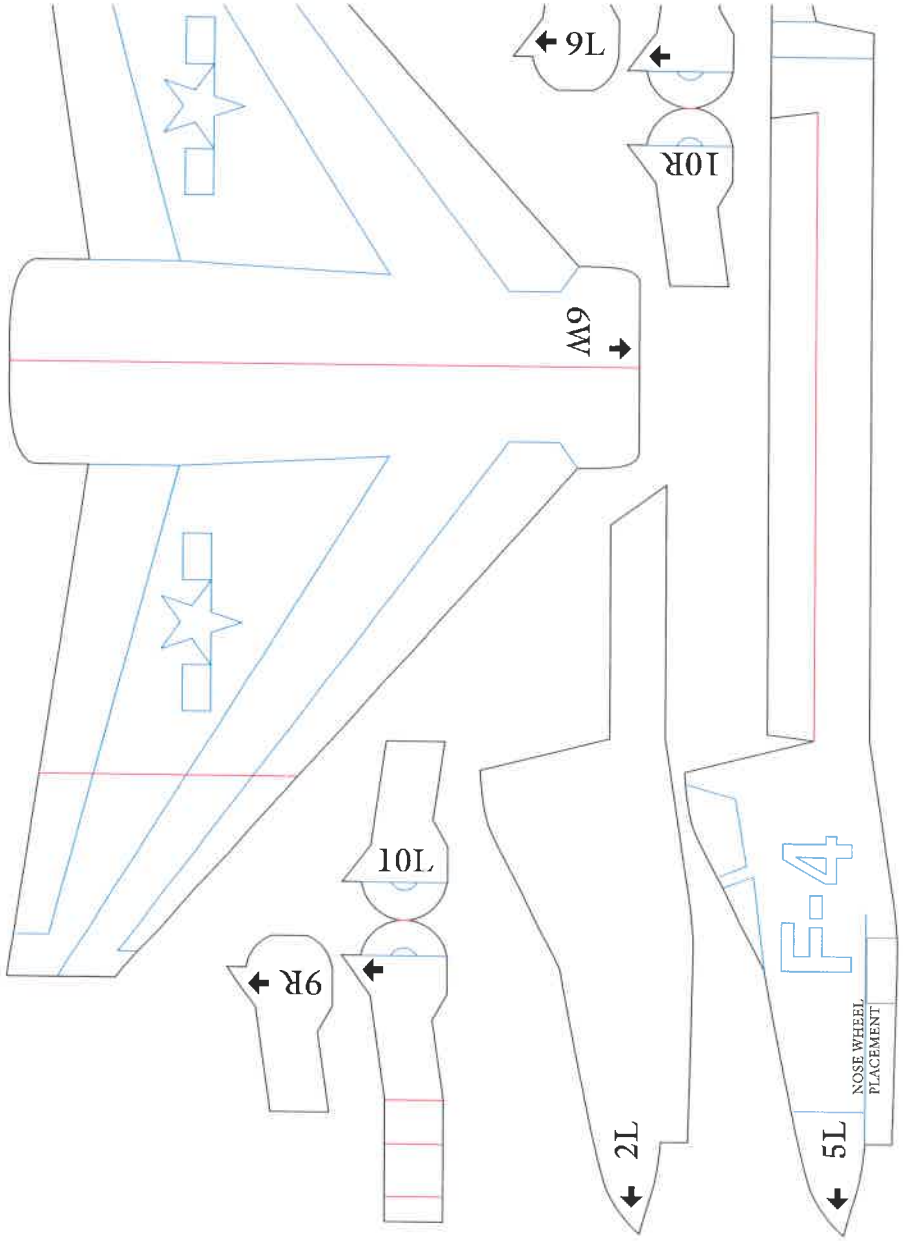
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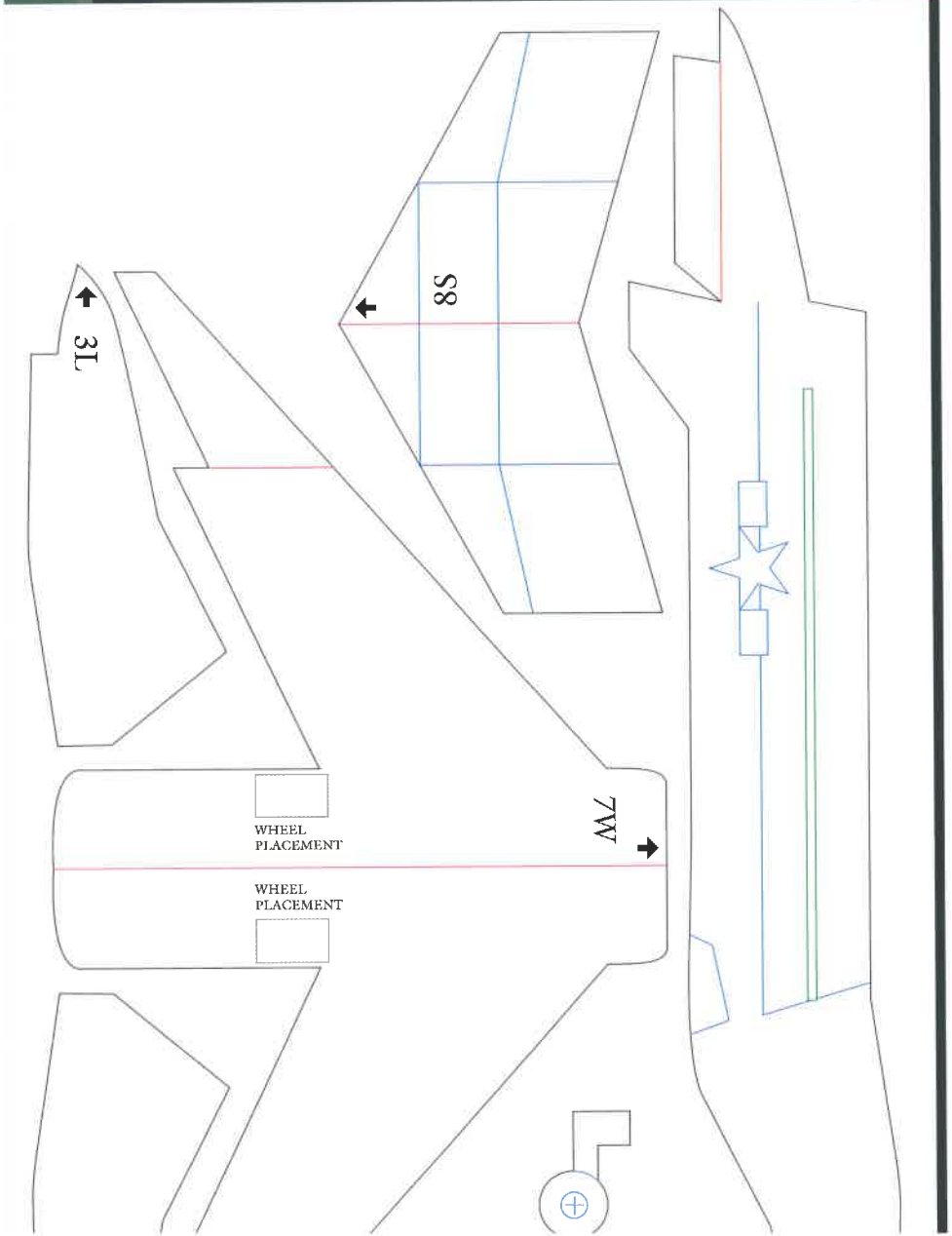
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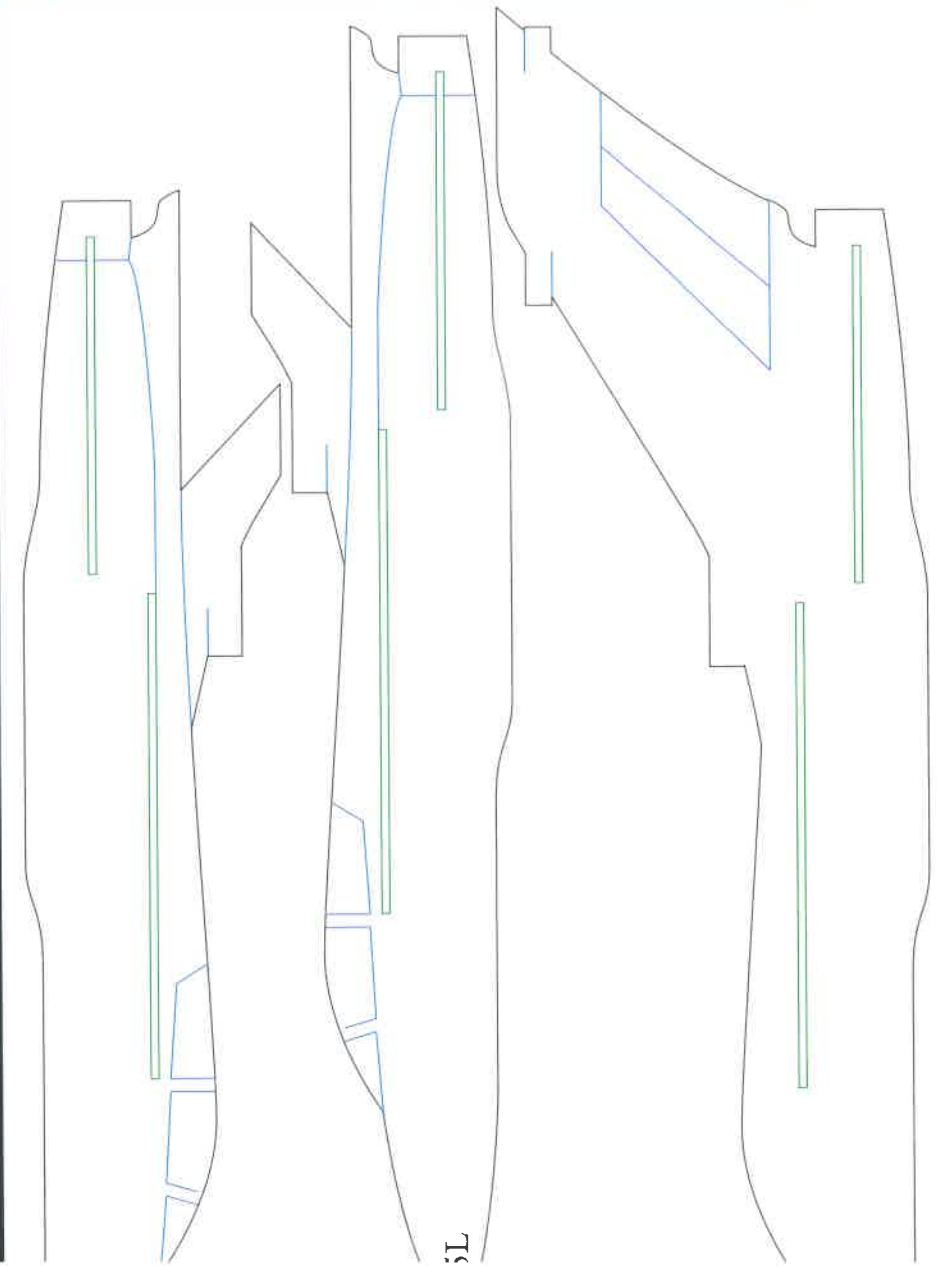

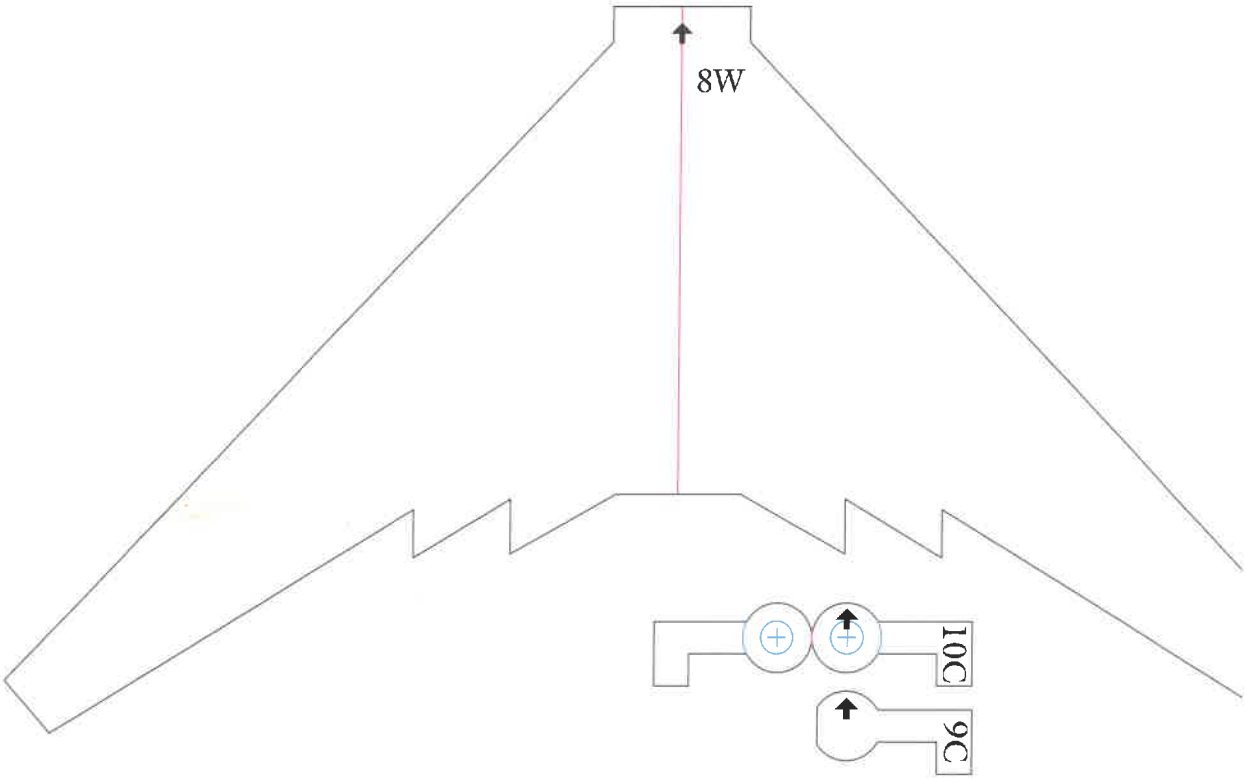
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L WHEEL PLACEMENT

10R
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9L
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oduction

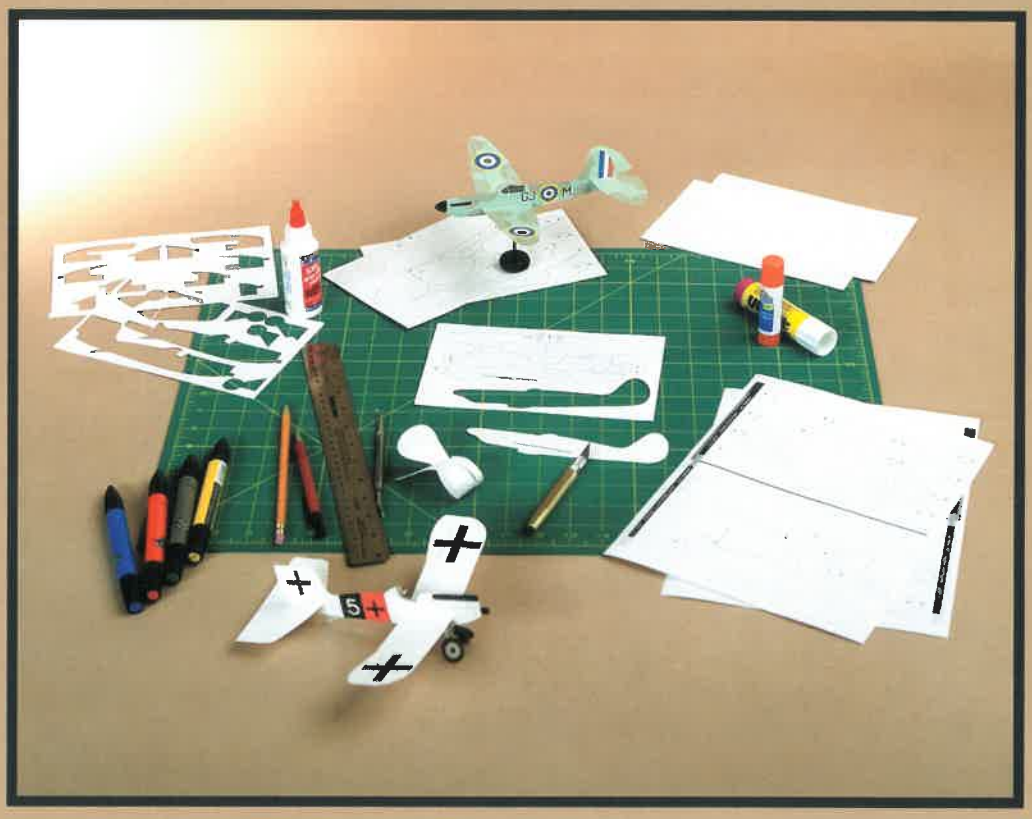
For those who enjoy making things, paper airplanes are a fun way to learn about aviation and how airplanes fly. Through representative examples from the hundreds of types of fighter planes built by various countries, the models and accompanying text in this book outline the progress in airplane design through the years. Also included is sidebar information on the basics of flight.

The paper models are cut from standard index card and when constructed with care, have reasonable flight characteristics. With details added they become convincing representations of the real thing.

In the models shown only enough detail is included to place each model in the right era, with no attempt made to accurately represent the markings of any air force or squadron. (Including the many thousands of different markings used in military aircraft is beyond the scope of this book. If accuracy in the markings is important, these may be found in books on the subject and on the internet.)

The proportions of the models are altered somewhat from their full-sized counterparts to suit the paper medium, and they are not in scale to each other. Notice in particular that the tails are large in relation to the rest of the plane. This is necessary to improve flight performance in such small-scale models.

Besides building and decorating the paper planes, all kinds of additional fun activities are possible by having flight competitions. These might include straight distance flights, landing as close as possible to some particular spot, flying through a hoop, or stunt flights.



A good work area
or model building
sists of a large flat
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es Small flat hinged
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The upward
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Drag The resistance of air on moving objects.

Elevator Control surface on the trailing edge of the horizontal stabilizer used to control pitch.

Fly-by-wire Aircraft control surfaces that operate electronically rather than mechanically.

Fuselage The body of an airplane.

Gravity The force of the earth keeping objects on the ground and giving them weight.

Horizontal stabilizer A flat horizontal surface directs the flow of air in aid of maintaining equilibrium.

Leading edge The front edge of an aircraft part.

Lift The force generated by the wings that counteracts the force of gravity.

Maneuver Skilfully making an airplane move in the correct manner and fly in the desired direction.

Pitch The rotation of an airplane causing its nose to go up or down.

Roll The rotation of an airplane causing the wingtips to rise or fall.

Rudder Control surface on the trailing edge of the vertical stabilizer used to control yaw.

Sonic speed (sound barrier) The speed at which sound waves move through the air.

Stall The condition that occurs when a wing's angle of attack is too great and lift stops.

Streamlining Shaping an airframe so that air flowing around it creates the least amount of drag.

Supercruise An airplane flying at supersonic speed for an extended time.

Supersonic The speed of an object greater than the speed of sound.

Swing wing geometry Wing design that allows them to sweep back at high speeds to maximize efficiency.

Thrust The force needed to move an airplane forward.

Trailing edge The back edge of an aircraft part.

Trim The adjustment of control surfaces so that an airplane in flight does not roll, pitch, or yaw.

Vertical stabilizer A flat vertical surface that directs the flow of air in aid of maintaining equilibrium.

Vortex The air that swirls in a circular manner behind each wingtip as air slips from the high pressure area below to the low pressure area above.

Wing loading The amount of weight a given area of wing is required to lift.

Wing span The measurement from wingtip to wingtip.

Wing washout Twist in a wing making the trailing edge at the wingtip higher than at the wing root.

Yaw The rotation of an airplane causing its nose to go left or right.

Further Reading

Angelucci, Enzo, ed. *The Rand McNally Encyclopedia of Military Aircraft 1914-1980.* The Military Press, New York, 1980.

Boyne, Walter J. *The Leading Edge.* Workman, New York, 1986.

Leverington, Karen, ed. *Fighting Aircraft of World War II.* Aerospace/Airlife, 1995.

Taylor, Michael J.H. *History of Flight.* Crescent, New York, 1990.

Wood, Derek. *World Aircraft Recognition Handbook.* Jane's, Coulsdon, 1992.

Other Books by Norman Schmidt

Discover Aerodynamics With Paper Airplanes. Pequis, Winnipeg, 1991.

Best Ever Paper Airplanes. Sterling/Tamos, New York, 1994.

Super Paper Airplanes. Sterling/Tamos, New York, 1996.

Paper Birds That Fly. Sterling/Tamos, New York, 1996.

The Great Kite Book. Sterling/Tamos, New York, 1997.

Fabulous Paper Gliders. Sterling/Tamos, New York, 1998.

Marvelous Mini Kites. Sterling/Tamos, New York, 1998.

Great Paper Jets. Sterling/Tamos, New York, 1999.

Incredible Paper Flying Machines. Sterling/Tamos, New York, 2001.

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